

Current History

A WORLD AFFAIRS MONTHLY

JULY/AUGUST, 1975

ENERGY AND SCARCE WORLD RESOURCES

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AMERICA'S FUTURE IN ENERGY	<i>Carroll Quigley</i>	1
OIL AND THE OPEC MEMBERS	<i>Ragaei El Mallakh</i>	6
ENERGY SELF-SUFFICIENCY IN THE SOVIET UNION	<i>Leslie Dienes</i>	10
THE ENERGY NEEDS OF WEST EUROPE, JAPAN AND AUSTRALASIA	<i>Eleanor B. Steinberg</i>	15
THE OIL-DEPENDENT DEVELOPING COUNTRIES	<i>Helen C. Low</i>	19
CHINA'S ENERGY RESOURCES AND PROSPECTS	<i>Yuan-li Wu</i>	25
MINERAL RESOURCES IN THE NEW INTERNATIONAL ORDER	<i>John Helliwell</i>	28
DEVELOPING ALTERNATIVE ENERGY SOURCES	<i>Harry Perry</i>	32
INTERNATIONAL CONTROLS OF SCARCE RESOURCES?	<i>Sterling Brubaker</i>	37
BOOK REVIEWS • <i>Readings on Food and Energy: Part II</i>		42
TWO MONTHS IN REVIEW		55
MAP • <i>The World's Oil</i>		Inside Back Cover

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Current History

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In the second of a two-part symposium on world resources, nine articles examine the world's energy needs and resources and evaluate the prospects for meeting world energy requirements in the late twentieth century. Our introductory article analyzes America's real energy needs, the false logic of special interest groups, and the need to stop wasting energy resources. The author concludes that: "An increase in net energy from coal should be regarded as a transitional stage . . . toward a new energy system . . ."; he urges changes in patterns of energy consumption "to produce a healthier and happier society. . . ."

America's Future in Energy

BY CARROLL QUIGLEY

Professor of History, Georgetown University

In 1973, President Richard M. Nixon announced Project Independence, his hope that the United States could achieve self-sufficiency in energy by 1980. This project is now almost dead, rejected or ignored by many government agencies and nongovernment opinions. Nonetheless, the project remains as a point of departure for any examination of this country's prospects in energy resources.

Project Independence pervades every aspect of our lives. Many vested special interests (including the richest and most influential corporations and individuals) are opposed to the very idea of self-sufficiency in energy resources. The owners of supertankers, which bring in oil from the Persian Gulf, and the railroad, which sends out one thousand shiploads of coal a year from Norfolk, Virginia, to Japan and other countries, object to Project Independence. In fact, powerful interests will work to prevent any real solutions to the "energy crisis"; and financial resources for such solutions will be meager unless we free ourselves from the interest groups and "experts" who created the crisis.

Most important, the goals and methods of Project Independence cannot be established by those methods of thinking and acting that have made the United States what it is today. The methods that made the United States the most powerful and most affluent state that ever existed by 1968 were the methods of reductionism. Such methods operate as follows: they isolate the problem as narrowly as possible; break

down the problem into the factors that determine what happens; quantify each factor; and vary these factors quantitatively to reach a specific desired material goal.

Energy self-sufficiency must be considered by holistic and not by reductionist methods. This does not mean that the United States must sacrifice either its affluence or its power. In fact, a shift from the reductionist methods of the past to the holistic methods of the future would probably increase American affluence and power by increasing the happiness, mental health, stability, and security of the American people.

The chief weakness of reductionist methods is that each problem is dealt with in isolation and the costs of solving problems are cumulative. But a holistic approach makes it possible to solve several problems at once by putting them together into a single system in which the problems provide solutions for one another; the different costs often cancel each other out. For example, consider three problems: the potential shortage of gasoline; atmospheric pollution from using gasoline (including lead poisoning from antiknock compounds put into motor fuel); and the enormous costs of dumping or disposing of trash. Today we pay these costs separately. But in December, 1973, *Science* published plans for a retort that would convert municipal refuse or other waste into methanol (wood alcohol) and would recover metals and molten glass.¹

About a year later, the state of Maine, which is

¹ *Science*, December 28, 1973.

very short of fuel, announced that it was going to use a similar scheme to convert the great tracts of dead trees there into methanol to be used as heating fuel. Methanol costs much less than gasoline (below 20¢ a gallon). It is 108 octane and can be used in automobiles in a ratio up to one-seventh of each tankful without modifying any parts of the engine, or in greater proportions up to 100 percent methanol, with slight engine changes. In addition, it has superior antiknock characteristics (far superior to lead). Any methanol fuel mixture, according to scientists at MIT's Lincoln Laboratory, "results in improved economy, lower exhaust temperature, low emissions pollutants, and improved performance, compared to the use of gasoline alone." These scientists add that methanol "is safe clean fuel for home heating and can be burned in power plants to generate electricity without polluting." Methanol does not have to be made from trash but can be made from many other substances, including coal (cost about 8¢ a gallon); it can be delivered or transported using current delivery systems for petroleum.²

A similar holistic approach may solve the following problems: the shortages and high costs of fertilizer (now largely made from natural gas); the shortage of natural gas; the pollution of streams, lakes and oceans by sewage; and the high costs of disposing of sewage. If sewage and other organic wastes were processed into fertilizer, at least in cities (as it is in Milwaukee), these four problems would help solve one another, with great savings in money and energy and a large decrease in environmental pollution. In fact, a Swedish toilet now available has no connections outside the house and converts sewage into dry powder fertilizer within the house without odors or the use of water.³

An example of the sharp contrast between reductionist and holistic views appears when we realize that although it is illegal for corporations to pay dividends out of capital, the American economy as a whole has been paying dividends (wealth) out of capital (our natural resource base) increasingly since 1840. In 1840, our resources included energy from the sun locked up in our reserves of fossil fuels (coal, gas and petroleum) millions of years ago, as well as in great forests that had captured energy from the sun in the centuries before 1840. Since 1840, and especially since 1940, we have used up those capital reserves of solar energy with increasingly reckless waste. Because we have been living off resource capital but treating it as income, our energy costs

have been very low. These low costs encouraged Americans to build up a wasteful "energy intensive" society, in which manpower was reduced by so-called "labor-saving" methods; later, land was also eliminated from the productive processes, and energy-wasting activities on a smaller percentage of our land ("high-rise urbanization") became the core of our economic and business activities. Since 1973, the rising costs of energy, really a blessing in disguise, are forcing us toward a reallocation of resources, which will ultimately bring manpower and land back into the productive system in a more decentralized, more diversified, more flexible, sounder, and more satisfying structure.

The vested interest groups in our society who profit from the destructive course we have been following insist that we must solve the energy crisis by increasing our speed upon that same course, using gross production figures to support their arguments. They ask us to exhaust our resources of fossil fuels even faster, to increase the pollution of our environment by abandoning our puny environmental protection measures, and to ignore the rising tide of social and emotional problems in urban and suburban life. These misguided "experts" insist that the cure for destructive technology is more destructive technology, and that the only way to solve one problem is to ignore or increase other problems. The truth is that the only permanent solution for any one of these problems lies in finding a solution for all these problems together.

Any extensive reallocation of resources must function as a kind of long-range master plan within which we must seek two other shorter-range goals. These are: to reduce the present waste of energy, which now amounts to over half the energy we use; and to increase the supply of energy, especially from the natural sources of energy income rather than from our remaining deposits of energy capital. Energy conservation, especially the elimination of energy waste, must be tackled before we seek new sources of energy.

There are only four sources of energy: the rotation of the earth, which can be harnessed through the tides; the internal heat of the earth, which can be tapped through geothermal wells; the sun; and atomic power, which can be obtained by fission or fusion. Today, atomic fission is achieved either in plants using moderated uranium or in "fast-breeder" reactors. Our only fusion power source is the sun itself, although considerable money and energy have been spent on research on fusion.

Tidal power has been harnessed in some other countries, notably in France. But the only promising location for its use in the United States is at Passamaquoddy Bay in Maine. This site has a potential of over two billion kilowatt-hours a year, but has been a subject of controversy since the New Deal

² T. B. Reed and R. M. Lerner, "Methanol: A Versatile Fuel for Immediate Use," *Science*, December 28, 1973, pp. 1325-1332.

³ R. Wolf, "Is There a Flushless Toilet in Your Future?" *Organic Gardening and Farming*, April, 1975, pp. 108-112. Per year per person, this toilet delivers about 60 lbs. of 20:12:14 fertilizer.

over 40 years ago. The quarrel is not yet dead, but the severe power shortage in northern New England makes it a more attractive project.

The internal heat of the earth is used in a few places in the United States, notably to produce a small fraction of the electricity of San Francisco, at a cost far below that of the rest of the city's power. But this is not likely to contribute much to our energy crisis in this century.

The energy of the sun can be captured either by physical processes, like focusing its rays to boil water, or by chemical processes, like raising carbohydrate crops to burn in living people, who can then utilize the solar energy released in digestion. The physical processes are of four kinds: from winds; from falling water; from the differential heat in the geosphere, either in the atmosphere through a heat pump or in the oceans through more complex and largely undeveloped techniques; and from the direct use of the sun's heat or light in various ways. The chemical processes are largely biological, of which the best known is through vegetation, either natural or agricultural. In these chemical processes, solar energy is locked up in more complex compounds made by plants out of carbon dioxide and water; this energy is released when these complex compounds, like sugar, are burned and reduced to the original carbon dioxide and water again. All fossil fuels are compounds that were created in the remote past by plants and animals by chemical capture of solar energy.

The energy income from the sun is practically limitless, whether we view it in terms of winds, vegetation, atmospheric, or oceanic heat, or direct radiation; but it cannot be used until we know how to collect it, store it, transform it, and transport it. All of these steps involve energy losses, and we know little about required techniques, especially storage. We must also remember money costs, environmental changes and social impacts. If we had a choice between large energy losses at low money cost and very efficient energy use with little loss, our choice might be based on the fact that the inefficient use of energy, by releasing heat into nature, may have very damaging long-range effects.

The real problems are not so much the capture or collection of energy (these are often done for us by nature as in winds or rainfall), but storage or transformation. Since fossil fuels are a natural method of storing energy, which can then be transformed or converted into heat, work, electricity or food, we have never given much attention to methods of storing energy, except for the familiar (and expensive) dam reservoirs and storage batteries. We could capture enormous amounts of energy from the wind, but we have developed no effective methods of storage.

It has been suggested that wind energy, converted

into electricity, could be used to separate hydrogen and oxygen in water; the hydrogen could then be transported by pipeline to plants far away where it could be burned to release again the energy that had separated it. This method is attractive because pipeline transportation is the most efficient method of transportation; we already have a network of pipelines; and hydrogen-burning is the least polluting kind of combustion, since it produces water vapor. For this last reason, hydrogen is the most desirable form of residential heating, for it needs no flue or chimney (a great heat-waster) and houses will not suffer from low humidity.

Another kind of energy storage that has been neglected is flywheels. Wind or electric energy could be stored in the momentum of vacuum-contained fiber flywheels, while smaller flywheels could be used as silent, totally nonpolluting, engines for vehicles. We are told by R. F. Post of Lawrence Livermore Laboratory that such a flywheel in an automobile body could be "revved up" in five minutes on any house electric outlet to 30 kilowatt-hours of momentum energy, enough to drive for 250 miles at 60 mph. Or the car could be left up to six months without running down.⁴ Travel in such a car would have an energy cost about one-fifth that of gasoline, with all the mechanical problems much simplified. The car could be braked by putting its kinetic energy back into the flywheel. And coin-operated electric outlet booths along the highway instead of filling stations would save those thousands of lives a year now lost in gasoline fires.

New methods of converting energy must be developed along with new methods of storage. Two that appear promising are heat pumps and fuel cells. A heat pump is like any refrigerator, except that it pumps heat into an enclosed space, like a house, from outside the enclosure, while a refrigerator pumps heat from the enclosure to the outside. A heat pump has two surprising characteristics that make it attractive. It works at more than 100 percent efficiency, since it can bring into the house from outside more than the heat equivalent of the energy it uses. And it can pump heat in even when the outside is very much colder, in effect pumping heat uphill. Moreover, the same heat pump can be used in reverse to cool the house in summer by pumping the heat outward instead of inward. If used in this way, a heat pump is cheaper to install and to operate than the usual separate heating and air conditioning systems.

Fuel cells need more development than heat pumps before they will be financially competitive with most methods for making electricity from fuel. They were very successful on the Apollo space missions, and prices are falling as technical improvements continue. They are silent, nonpolluting, and operate with almost equal efficiency at all parts of their operating

⁴ See R. F. Post, *Scientific American*, December, 1973.

range (compared to conventional electric generators that operate with low efficiency below 40 percent) at full speed and have very much lower efficiency at lower speeds. Such fuel cells oxydize any fuel, but work best on hydrogen, joining the two gases together, with the released energy appearing as electric current.

Much of the energy waste and pollution of our present energy system (based on the generation of electricity from fossil fuels at central power systems and carried long distances over wires) come from intrinsic weaknesses in this system. Less than 40 percent of the fuel energy is taken from the fuel even under the best conditions, with much pollution and great loss of heat to the environment, and considerable energy loss in carrying electricity over wires to the consumer. Moreover, since the plant runs at full power for only a few hours a day, with less demand for current during much of the day, it operates at low efficiency during non-peak hours. Since electricity, like wind power, cannot be stored, electric utilities have tried to store current by pumping water into high reservoirs during slack hours and using the power of the falling water to generate current again at the peak hours. This is wasteful; it requires very expensive, large reservoirs, and takes years to build, especially if the project arouses controversy.

To encourage our energy system to develop better methods, we must allow energy costs to rise, especially the cost of fossil fuels. Fossil fuel costs are bound to increase anyway, as they become scarcer and as extraction costs increase. Not only must the price of petroleum products be allowed to rise, but electricity rate structures must be reformed to reduce waste. At present, utility rates reward waste by reducing the prices of successive increments of electricity as more is used by a customer.

Because the efficiency of most utility systems averages about 31 percent, a revised rate structure with higher fuel costs would encourage the more efficient practice of generating electricity locally and using the incidental heat, which is lost in a central power station, for heating and cooling the buildings which receive the electricity. If the fuel was nonpolluting, like natural gas, methanol or hydrogen, we could increase the output of current while reducing electric generators' waste and pollution. This decentralization of electricity generation is supported by the United States Department of Housing and Urban Development, but it is violently opposed by the profit-seeking energy establishment, although it would waste as little as 15 percent of the fuel it used, compared to

the over 60 percent now wasted in coal-fired central utility plants and the more than 70 percent wasted in uranium nuclear generating plants, both types causing great environmental pollution.

At present, almost all the plans for increased energy supply deal with individual installations, estimating costs in money terms instead of in real terms, and omitting costs that can be "externalized," that is, excluded from the corporation's accounting methods by being charged to the community. Recently, feeble efforts have been made to require environmental impact evaluations, but in all private installations, decisions are still made in terms of money costs, not energy costs. It must be evident that what is profitable to an enterprise in money terms may be disastrous to the country in real terms. The Arab oil embargo was profitable to petroleum corporations, but, in the short run at least, it was damaging to the country and to millions of individuals. The significant decisions in the energy crisis must be made in real terms, not money terms, on the basis of the general welfare and not for a few favored business firms, and must be made within a total energy budget for the country.

For example, it is claimed that the only solution to the energy crisis is a crash program to build nuclear power plants, especially "fast-breeder" reactors. We are told that a projected nuclear generator will produce one million kilowatt hours of electricity, but we are not told how much energy outside the reactor is needed to build, maintain, and protect the plant, nor are the costs of the reactor to the community discussed. The whole story is too complex to explain here, but, briefly stated, the energy input costs of nuclear power are greater than the foreseeable energy output, so that there is little or no net increase in our energy supply. Even in money terms, there is no gain. In 1973, electricity from nuclear plants comprised less than 1.5 percent of our total supply, about the same amount as the energy supplied from burning wood. Yet private industry and the Atomic Energy Commission (which insisted that nuclear energy would provide us with almost limitless supplies of "cheap, clean power") together spent over \$40 billion to create a nuclear power business between 1947 and 1970. The internal costs of producing nuclear energy increased from \$135 a kilowatt hour in 1960 to \$555 in 1972; they have increased much more since. This compares with a few cents per kilowatt hour for electricity from fossil fuels.

The nuclear generators used until 1972 were moderated uranium reactors, which can be used only a few years more; our domestic supplies of uranium will be exhausted by 1990, according to a United States Geological Survey report of May, 1973. This is long before our domestic resources of fossil fuels will be used up. Yet, according to Wilson Clark,⁵

⁵ Wilson Clark, *Energy for Survival: The Alternative to Extinction* (New York: Anchor-Doubleday, 1974), p. 652. A good guide to technical details is Hans Thirring, *Energy for Man: Windmills to Nuclear Power* (Westport, Conn.: Greenwood Press, 1968), p. 409ff.

"virtually all government funds spent for research into all energy technologies since World War II have been devoted to the development of nuclear reactors." This is a result of propaganda and the suppression of evidence by those interested in the project, including the AEC itself.

Interested parties have tried to conceal the dangers of nuclear power plants and the fact that such plants are unreliable and dangerous. The plants are always behind schedule in construction, sometimes years behind; they suffer constant breakdowns, and all nuclear breakdowns are expensive and of long duration because of the dangers of radioactivity. These dangers are so great that even the overly optimistic estimates of the AEC showed that it would be financially impossible for private industry to build nuclear reactors because of the high costs of liability insurance. AEC figures showed that a major nuclear accident might kill 3,400 persons, contaminate up to 150,000 square miles more or less permanently, and cause \$7 billion in property damages.

To persuade private industry to invest in nuclear power under these conditions, the Price-Anderson Act of 1957 arbitrarily limited the aggregate liability for each nuclear reactor accident to \$500 million, only one-fourteenth of the AEC damage estimate; since that time, most private insurance policies for individuals have been rewritten to exclude any protection against nuclear radiation damage. Nuclear energy costs continue to skyrocket, and plant breakdowns are increasing in frequency. The *Wall Street Journal* of May 3, 1973, summed up the situation on nuclear generators: "Their unreliability is becoming one of their most dependable features."

If this is true of the already obsolete moderated uranium plants, it is even truer of the newer "fast breeders," despite the fact that on June 4, 1971, President Nixon declared that: "our best hope today for meeting the nation's growing demand for economical clean energy lies with the fast breeder reactor." Two-thirds of the earliest fast breeders broke down on their trials from fuel-core melting, the most dangerous type of reactor accident. But without fast breeders there is no future for nuclear power, because of the enormous cost and short supply of the U235 used in moderated uranium reactors. The fast breeder can be started on natural uranium, but it continues running on plutonium, which it creates itself in increasing amounts, so that it must be re-

moved. The production of plutonium creates insoluble problems of security, accelerating to astronomical levels the financial, social and security costs of nuclear proliferation and waste disposal.

Plutonium, a radioactive element not found in nature but produced by both types of nuclear generators, is an incredibly deadly poison, far more poisonous than botulism and 35,000 times as poisonous as the cyanide used by the German Nazis for instant suicide. Worse than that, plutonium explodes spontaneously in any mass over about 15 pounds, and a fast-breeder reactor needs almost two thousand pounds to operate. Plutonium is the explosive force in our nuclear weapons. Today any gang of determined persons who have access to the wastes of a fast breeder can obtain by stealth or by violence a few small cans of plutonium to use as poison or to make a nuclear bomb.

AEC rules excluded any consideration of the costs to the community of projected nuclear generators, and the agency's rules have not been changed to fit the Environmental Protection laws of 1970. As a result, it has been necessary to ask the courts to force private nuclear plants to conform to environmental protection rules. The waste products of atomic energy are radioactive, poisonous, and corrosive. Uranium wastes have a half-life of 4.5 billion years, while plutonium wastes have a half-life of 24,000 years; both are also mixed with other radioactive materials. Each waste remains dangerously radioactive for about ten times its half-life. This means that nuclear wastes must be guarded in containers that corrode and must be replaced, for liquid wastes, at least every 20 years. Thus for thousands of generations wastes must be kept out of the environment, like underground waters, and out of the hands of desperate men. This is physically impossible, and the costs of trying to protect the environment against such wastes will soon be unbearable. In fact, at Hanford, Washington, at the original plant for making plutonium for weapons, in the course of only 30 years, the corroded stainless steel tanks were not replaced within the maximum period of 20 years; thus up to half a million gallons of bubbling uranium wastes have leaked into the earth from 108 over-age tanks.⁶

Threats from the increased use of fossil fuels are more remote, and arise from thermal pollution in the atmosphere rather than in the water. All estimates about the size of United States petroleum reserves

(Continued on page 43)

⁶ R. Gillette, "Radiation Spill at Hanford," *Science*, August 24, 1973, pp. 728-730. It has been suggested that nuclear energy could be handled safely if the whole process, including all wastes, were sealed off from the environment and if the heat were used to split water to obtain hydrogen for use in a hydrogen economy. See W. Häfele, "A European View of Energy," *Science*, reprinted in Philip H. Abelson, ed., *Energy: Use, Conservation, and Supply* (Washington, D.C.: American Association for the Advancement of Science, 1974).

Carroll Quigley, a contributing editor of *Current History*, is the author of *Tragedy and Hope: A History of the World in our Time* (New York: Macmillan, 1966) and *The World Since 1939: A History* (New York: Collier Books, 1968).

"Given OPEC's strength in reserves, the predominance of petroleum in energy consumption for years to come, and the limited and depleting nature of oil and natural gas, both producers and consumers have common interests. . . . There is growing acceptance of the interdependence that characterizes the world, not only in petroleum, but in commodities like iron ore, manganese, chromium, bauxite, nickel and tin. . . ."

Oil and the OPEC Members

BY RAGAEI EL MALLAKH

Professor of Economics, University of Colorado

IN JUST A FEW MONTHS after October, 1973, the Organization of the Petroleum Exporting Countries (OPEC) moved from a relatively unknown status to win wide recognition in the United States. But although the acronym OPEC is recognized, there has been no concomitant rise in understanding the organization, its objectives, and the way it reaches its goals. It is perhaps unfortunate that OPEC's meteoric rise to fame came abruptly during a period of overlapping international crises. Perhaps recognition could not have come otherwise. Given the background of the most recent United States experiences as the world's major energy consumer, a near hysteria erupted among some commentators and officials, who attached a malevolent aura to OPEC.

Before discussing the importance of OPEC to the international oil picture, basic misconceptions should be clarified. First, the membership of OPEC is frequently garbled in media reporting. There are currently 12 full members (Algeria, Ecuador, Indonesia, Iran, Iraq, Kuwait, Libya, Nigeria, Qatar, Saudi Arabia, the United Arab Emirates and Venezuela) and one associate member (Gabon). Only seven of these are Arab states; Iran, a Middle Eastern country, is not Arab. Any nation can become a member of OPEC if it is a substantial net exporter of crude petroleum and is unanimously accepted by all five founding members of the organization (Iran, Iraq, Kuwait, Saudi Arabia and Venezuela).¹ Hence, the

casual use of the terms "Arab oil cartel" and OPEC interchangeably clouds the nature of the organization.

OPEC was created in September, 1960, as a direct response to the operating companies' unilateral cuts in posted prices for crude oil earlier in 1960 and in 1959. These drastic slashes sent the producer governments' revenues plummeting. Thus, the most clearly defined objective of OPEC (Resolution I.2 adopted at the Baghdad Conference in 1960) was the stabilization of prices. Other goals included the coordination of the petroleum policies of member countries and a determination of the means for safeguarding their interests individually and collectively, with attention directed to the necessity of ensuring a steady income to the producing states, an efficient, economic and regular supply of petroleum to the consuming countries and, finally, a fair return to those investing capital in the oil industry.

Since OPEC is not a commercial entity and cannot impose any decision on either its own members or other nations, to call it a "cartel" in the classic economic sense might be misleading. Neither OPEC nor its individual member states have acted monopolistically in "selling less than would be in one's economic interest at the going price in order to raise the price."² The 1973 Arab oil embargo was political, not geared to raising oil prices; a price rise was a by-product resulting from the supply and demand situation. Moreover, OPEC has never been able to implement production programming, although it has been able to move in the areas of prices and taxes. Finally, after the Arab embargo, the sizable non-OPEC oil producers and exporters like Canada and Mexico benefited price-wise, at least to the same extent if not more than member states.³

The relationship between producer and consumer reflects short-term fluctuations and intermediate and long-term trends. For example, prior to the 1970's, an overwhelmingly "buyer's" market in oil was trace-

¹ The OPEC candidate should also have "fundamentally similar interests" with other members and be accepted by three-quarters of the full membership. Article 7, *OPEC's Statute* (Vienna, 1971).

² Robert Mabro, "Can OPEC Hold the Line?" *Middle East Economic Survey*, Supplement, February 28, 1975, p. 1.

³ The activities of OPEC have been traced succinctly in Shukri Ghanem, "OPEC: A Cartel or a Group of Competing Nations?" in Ragaei El Mallakh and Carl McGuire, eds., *Energy and Development*. (Boulder, Colorado: The International Research Center for Energy and Economic Development, 1974), pp. 175-184.

Table I: Oil Reserves and Production for OPEC and Selected Countries

COUNTRY	RESERVES as of January 1, 1975		OIL PRODUCTION	
	Oil (1,000 barrels)	Gas (billion cubic feet)	Estimated 1974 (1,000 b/d)	% Change from 1973
Algeria ¹	7,700,000	229,000	888.8	-19.2
Bahrain	336,000	6,600	68.0	—
Canada	9,400,000	52,500 ²	1,682.0	-2.9
Ecuador ¹	2,500,000 ³	5,000	232.0	12.5
Egypt ⁴	3,700,000	3,500	118.3	-42.8
Gabon ¹	1,750,000	7,000	182.0	20.1
Indonesia ¹	15,000,000	15,000	1,457.0	10.0
Iran ¹	66,000,000	330,000	6,128.0	0.6
Iraq ¹	35,000,000	27,500	1,829.3	2.0
Kuwait ¹	72,800,000 ⁵	32,000	2,600.0	-7.4
Libya ¹	26,600,000	26,500	1,700.0	-21.6
Mexico	13,582,000	15,000	513.5	17.1
Neutral Zone ^{1, 5}	17,300,000	7,500	485.4	-4.3
Nigeria ¹	20,900,000	45,000	2,300.0	15.0
Oman	6,000,000	2,100	297.0	-0.7
Qatar ¹	6,000,000	8,000	546.0	5.4
Saudi Arabia ¹	164,500,000	55,000	8,400.0	11.7
United Arab Emirates ^{1, 6}	33,920,000	203,000	2,032.0	37.2
United States	35,299,839	250,000	8,945.0	-2.9
Venezuela ¹	15,000,000 ⁷	43,000	3,025.0	-10.0
TOTAL NON-COMMUNIST WORLD	604,297,189	1,709,064	46,382.0	2.0
TOTAL OPEC	484,970,000	1,033,500	31,805.5	—
TOTAL WORLD	715,697,189	2,555,064	56,722.0	3.0

¹ OPEC member.² Does not include Arctic gas.³ Revised.⁴ Does not include occupied Sinai fields.⁵ Shared by Kuwait and Saudi Arabia.⁶ Abu Dhabi, Dubai, and Sharjah.⁷ Does not include the Orinoco heavy oil belt.Source: *Oil and Gas Journal*, December 30, 1974, pp. 108-109.

able to a number of factors. The United States was largely self-sufficient and was even an exporter of oil under certain circumstances. With a very low price on foreign oil, the exporting countries competed in raising their output in order to raise the revenues required for their developmental needs. This, in turn, yielded even greater supplies of cheap energy, feeding indifference to conservation in consuming countries, especially in the affluent United States, where industry and the transport sector continued to design for the future without serious attention to the energy input and the efficiency of energy use.

As 1970 opened, the oil market balance tipped toward the sellers. American petroleum and energy production was dropping, and the United States was becoming increasingly dependent on oil imports. At the same time, economic growth in the OECD countries (the Western industrialized states and Japan) required higher energy consumption, and the indus-

trialized world's inflationary spiral took off. United States oil imports alone climbed from 3.93 million barrels per day in 1971 to almost 6.21 million in 1973, an increment of more than 50 percent.⁴ In 1975, the imports level is about 6.5 million barrels per day (b/d).

U.S. SELF-SUFFICIENCY?

Project Independence, initially announced in 1973, aimed at United States self-sufficiency in energy by 1980. Since then, the goal of Project Independence has been modified; it is hoped that energy "vulnerability" can be ended by 1985. Whether this revamped target is attainable is still doubtful. First, the cost and technical difficulties involved in developing new sources of energy (shale oil, solar, and nuclear) are significant. It has been estimated that investment in new energy facilities to achieve a high degree of self-sufficiency by 1985 for the United States alone will be on the order of \$500 billion (without any inflationary increases included in the projections); world petroleum investment requirements are

⁴ British Petroleum Company, Ltd., *Statistical Review of the World Oil Industry, 1973* (London, 1974).

expected to be in excess of \$1 trillion over the same time span.⁵ This is a staggering amount in the face of persistent difficulties in obtaining the needed credit.

Second, the price of OPEC oil, high as it seems, remains below the minimum projected cost of \$15 per barrel for shale oil or synthetic fuels production.⁶ Third, Canadian oil, which traditionally has represented one-fourth of United States oil imports, is drying up. The "Canada first" policy in energy announced by Canada in November, 1974, is geared to the conservation of petroleum for Canadian use. The limit on Canadian exports to the United States will be 800,000 b/d by January 1, 1975, dropping to 650,000 b/d by the middle of the year, and to zero by 1983.⁷ And Canada has always been considered a so-called "secure" source, particularly when compared to Middle East sources.

Fourth, output from existing petroleum resources in the United States depends on the availability of reserves. Unfortunately, American oil reserves, it has just been announced, dropped one billion barrels in 1974; proven natural gas reserves were down five percent.⁸ Table I compares the availability of petroleum reserves and output figures for OPEC and non-OPEC producers. From 1964 to 1974, OPEC's share in world oil production rose from 43.7 percent to 56 percent. In 1974, OPEC accounted for 80 percent of the non-Communist total and almost 68 percent of the world's reserves of oil.

Fifth, if the United States hopes to expand production from existing sources and, perhaps more important, to discover new petroleum reserves, the current legislative disarray could have a negative impact. Whether one approves or disapproves of the oil companies, the recent congressional action to cut off the depletion allowance will act inevitably to depress the possibility of expansion of exploration for domestic supplies.

Sixth, availability and the price of OPEC oil to the United States and other importers depend on the supply picture. By the spring of 1975, there was considerable talk of a "glut" in the world oil market. However, the glut is traceable to the excess producing capacity of some OPEC members rather than to an actual petroleum surplus. Worldwide oil consumption did not rise in the amount projected from past consumption patterns. In fact, petroleum consumption in the United States fell 2.3 percent in 1974; this decline was a reflection of declining economic

activity because of recession rather than of conservation measures.⁹ Nonetheless, with a combination of expected economic recovery and a drop in domestic output, most experts conclude that United States imports of oil will increase from the present 6.5 million b/d to about 8 million b/d by 1977.¹⁰

Turning to pricing, the increases won by OPEC members in the early 1970's (the Tripoli, Teheran, Geneva I and II agreements) were premised largely on inflation and on devaluations of the dollar. The essentially seller's market was strengthened by Arab production cutbacks linked to the 1973 embargo, which considerably tightened supply constraints. The further increase, it can be argued, finally brought crude oil prices into line with the prices of other commodities; aside from the insufficient supply during the short embargo period, the truly disadvantageous factor was the fact that the repricing of petroleum was not gradual.

OPEC members believe that they are finally receiving the price they deserve. The cost of petroleum is tied directly to the cost of industrial products, and commodity prices have risen more swiftly than oil prices. In real terms, the price of petroleum was lower in 1973 than in 1959. Some OPEC members have only 15 to 20 years of reserves left, at their current output rate. These countries cannot be expected to sacrifice their future, including the development of more diversified and self-sustaining balanced economies, without some sort of trade-off. While some few American politicians have suggested that food be used as a countermeasure to oil, they have ignored a most crucial distinction in equating food and oil, i.e., agricultural products are renewable, although petroleum is a wasting asset. Those who regard the oil nations' income of approximately \$10 per barrel excessive should look at per barrel taxes on gasoline in the consumer nations: estimated at \$5 in the United States (excluding the new tariff), \$14 in Japan, and \$28 in West Europe.

Although OPEC members suddenly experienced rising revenues, their economies frequently could not absorb the oil-generated funds domestically. A significant portion of these surplus funds was moved back into international channels as investment in the industrialized countries and aid-investment in the developing world. For example, \$11 billion (about 20 percent) of the so-called surplus OPEC funds were invested in the United States in 1974. Some \$7.5 billion (12.5 percent) flowed into United Kingdom assets, apart from the Eurocurrency deposits in that nation. And approximately \$5.5 billion (nine percent) may have comprised direct lending by OPEC members to official and quasi-official institutions in developed nations other than the United States and the United Kingdom, while \$3.5 billion (six percent)

⁵ Robert W. Baldwin, "Oil and Alternate Energy," in El Mallakh and McGuire, *op. cit.*, p. 195.

⁶ *Ibid.*, p. 197.

⁷ *Oil and Gas Journal*, December 2, 1974, p. 23.

⁸ *Wall Street Journal*, April 2, 1975.

⁹ *Petroleum Intelligence Weekly*, December 30, 1974, p. 4.

¹⁰ *Christian Science Monitor*, April 17, 1975.

represented OPEC investments to international financial bodies like the World Bank and the International Monetary Fund.¹¹

OPEC AND THE THIRD WORLD

The OPEC-developing countries relationship is dual. OPEC members consider that they themselves belong to the developing bloc, since a surplus of capital alone cannot be equated with an economically advanced status. Additionally, some OPEC members, like Indonesia and Algeria, still require imported capital. Almost all OPEC members have either single-product economies (oil) or economies based on only a few raw material exports; most OPEC economies are not even self-sufficient in the area of food. As is true of developing countries everywhere, OPEC members depend on imports of industrial products, capital equipment and technology. Furthermore, the third world includes the OPEC economies within its own bloc, as evidenced in the Conference of Developing Countries on Raw Materials held in Dakar in February, 1975, where strong support was given OPEC by all the developing nations.

At the March, 1975, Algiers meeting of OPEC, speaking for and as an integral part of the developing world, OPEC outlined the following goals of the less developed nations. (1) The economically advanced countries must support measures instituted by the developing nations and directed toward the stabilization at equitable levels of prices for their raw material exports and other primary commodities. (2) The developed states, particularly major food producers and exporters, should actively work to formulate and implement an effective food program for the most affected developing countries. (3) The industrialized world can accelerate the development process of the third world through the adequate transfer of technology. (4) The developed countries are urged to open their markets to imports from the developing world of hydrocarbons (petroleum and petroleum products), other primary commodities, and manufactured goods, without discriminatory measures against the developing states, including OPEC members. (5) The Organization for Economic Cooperation and Development (OECD) hopefully will facilitate its international commitments for the second United Nations Development Decade as a minimum contri-

bution to be increased by the ablest developed states to benefit the most affected developing countries.

OPEC members have become relatively unnoticed but massive extenders of aid to the developing bloc. In 1974 alone, OPEC assistance disbursements amounted to more than \$7 billion; \$2 billion provided through the International Monetary Fund's Oil Facility (designed to assist in defraying the higher import costs for oil); \$2.3 billion in loans to the World Bank and other multilateral development institutions; \$3 billion in bilateral grants and loans to oil-importing countries of the third world.¹² In the forefront as sources of assistance funds were Saudi Arabia, Kuwait, Iran, and the United Arab Emirates.

To place the scope of OPEC aid in perspective, one should recall that this is almost three times the economic aid extended by the United States in the same year. More striking, some OPEC members' assistance commitments in 1974 ranged from 4 to 16 percent of their respective national incomes. This can be compared to one percent of the national income of France extended in assistance, 0.3 percent for England, and only 0.4 percent of the national income of the United States committed for economic assistance.¹³ Nor can the decline in aid from the industrialized countries be attributed to the rise in oil prices or the pressure of higher energy bills on economically advanced petroleum importers. The 1974 OECD report on its members' aid programs of the preceding decade—a ten-year span of continuous economic growth—noted that, in real terms, aid had dropped seven percent.¹⁴

Given OPEC's strength in reserves, the predominance of petroleum in energy consumption patterns for years to come, and the limited and depleting nature of oil and natural gas, both producers and consumers have common interests in three major areas: (1) the conservation of a nonrenewable asset; (2) the development of alternative energy sources; (3) the utilization of petroleum increasingly in petrochemicals rather than burning for fuel in power generation. There is growing acceptance of the interdependence that characterizes the world, not only in petroleum but in commodities like iron ore, manganese, chromium, bauxite, nickel and tin. The United States, for example, imports from one-third to often over 90 per-

(Continued on page 47)

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¹¹ Statement of the Honorable William E. Simon, Secretary of the Treasury, before the Joint Economic Committee, Washington, D.C., February 5, 1975, *Department of Treasury News*, February 5, 1975, pp. 13-14.

¹² International Monetary Fund, *IMF Survey*, March 24, 1975, p. 81; address of M. W. Hosny, Counsellor for Economic Affairs, Permanent Mission of Egypt to the United Nations, to the Global Economic Conference sponsored by William D. Witter, Inc., New York, April 11, 1975.

¹³ Peter Kellner, "OPEC Shares Its Wealth," *Middle East International* (London), April 1975, p. 7.

¹⁴ *Ibid.*, p. 6.

"The Soviet energy mix today is highly favorable and shows no excessive dependence on any single primary form and source of supply."

Energy Self-Sufficiency in the Soviet Union

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THE SORRY postwar record of the Western industrial powers in the management of their energy resources has called forth a grudging respect for the purposeful, long-range energy planning in the U.S.S.R. and for the relative stability of Communist resource policy. The insecurity and real or supposed inadequacy of Western fuel supplies at "acceptable" costs are today often contrasted with the dependability of Soviet domestic resources and the vast size of Soviet reserves. With a gross national product (GNP) perhaps three-fifths that of the United States, the U.S.S.R. is a huge consumer of energy, the demand for which has been growing at a very rapid pace. Yet, alone among industrial countries (since even Canada is soon to lose this distinction), the Soviet Union is self-sufficient in all forms of energy and is, in fact, a major exporter. Soviet petroleum exports today exceed the output of most OPEC nations; the U.S.S.R. also exports large amounts of coal and growing quantities of electricity, and is about to become a major net exporter of natural gas as well.

In the Soviet Union, the energy sector is a strongly interconnected subeconomy, where a high degree of substitution is feasible and decisions concerning a major energy form crucially affect other parts of the sector. To an unknown extent, the energy needs of East Europe are linked with this subeconomy and are a factor in Soviet energy decisions.

The Soviet energy mix today is highly favorable and shows no excessive dependence on any single primary form and source of supply. Following the structural conservatism of the Stalin years, the energy balance was thoroughly modernized within two decades. In 1950, the share of solid fuels was almost

four-fifths of both total consumption and production. In the next two decades, it declined by roughly one-half. Increased use of petroleum and gas reduced the mean production cost of one ton of standard fuel (1 ton = 7 million kilocalories) by at least three rubles,¹ and yielded large economies through more efficient heat capture, locomotive power, reduced handling charges and far greater flexibility in chemical synthesis.

As is the case in all countries today, the energy balance in the U.S.S.R. is dominated by fossil fuels. The contribution of primary electric power (power not generated from conventional fossil sources) is, and has always been, minor, even when primary electricity is added to the mix in a manner biased in its favor. Despite big projects under way, the contribution of hydroelectricity will decline substantially. Before the end of the century, no more than one-tenth of Soviet generating capacity and less than one-tenth of actual output is expected to be hydraulic, representing under one-half of one percent of all primary energy supply. The U.S.S.R. is just entering the age of economically viable nuclear energy, whose contribution so far has been negligible (see Table 1).

THREE DIMENSIONS OF THE SOVIET ENERGY SYSTEM

Any attempt to understand the dynamics of the Soviet energy system requires a three-dimensional view. The first dimension is represented by the high degree of sectoral interdependence and the ability to make substitutions within the energy sector, particularly in boiler and furnace uses, which in the U.S.S.R. account for some four-fifths of all energy demands.² The second dimension is geographical. The Soviet energy economy operates in a geographic space that embraces one-sixth of the earth's surface, displays huge variations in resource endowment, extraction possibilities and accessibility, and suffers from a crushing areal discordance between energy demands and supplies. The third dimension, the political, is the hardest to outline. To Soviet leaders, the energy sector has always represented one of the most imposing "commanding heights" of a socialist

¹ Leslie Dienes, "Geographical Problems of Allocation in the Soviet Fuel Supply," *Energy Policy*, vol. 1, no. 1 (June, 1973), pp. 3-4.

² All boiler and furnace use in 1970 amounted to 904 million tons of standard fuel, henceforth SF (1 ton = 7 mill. kilocalories). Total primary energy consumption was 1117.9 million tons. Vsesoiuznyi institut nauchnoi i tekhnicheskoi informatsii, *Razrabotka nefiannykh i gazovykh mestorozhdenii*, Tom 4 (Moscow, 1972), pp. 44-45; and *Narodnoe khoziaistvo SSSR* (henceforth *Narkhoz*) v 1973 g. (Moscow: "Statistika," 1974), p. 62.

Table 1: The Soviet Energy Mix, 1973

TYPE OF ENERGY	PRODUCTION		CONSUMPTION		NET EXPORT + OR IMPORT -
	Million Tons of Standard Fuel	Percent of Total	Million Tons of Standard Fuel	Percent of Total	Million Tons of Standard Fuel
Petroleum	613.5	41.8	471.5	35.7	+ 142.0 *
Natural gas	282.4	19.3	287.0	21.7	- 5.7 }
Coal and Lignite	468.8	32.0	459.5	34.8	+ 12.5 }
Peat, shale & firewood	55.9	3.8	55.9	4.2	0
Hydroelectricity***	42.0	2.85	42.0	3.2	0
Nuclear power	4.1	0.25	4.1	0.3	0
TOTAL	1,466.7	100.0	1,320.0	100.0	148.8 **

N.B. 1 ton of standard fuel = 7 million kilocalories. Roughly equivalent to the heat value of one ton of very good hard coal.

* Includes crude and refinery products.

** To these should be added about 3.5 million tons of standard fuel equivalent of coal and gas, exported *via* electricity.

*** Hydroelectricity added to the fuel mix according to the 1973 heat rate at Soviet district stations, i.e., the amount of fuel needed to generate an equivalent amount of electricity at thermal plants.

Sources: Fuel production from *Narkhoz SSSR v 1973 g.*, p. 258. Export and import in physical units from *Vneshniia tor-goulia SSSR za 1973 god*, pp. 70-71, 101 and *Narkhoz SSSR v 1973 g*, pp. 790-92. They have been converted to standard fuel equivalent.

economy, where rational investment and allocation decisions must be solved without any intrusion of spontaneous market forces. While the rationality of such decisions today clearly embodies the economic reality of relative costs and prices, it just as clearly embodies the long-term goals of national security, full control over supplies, and the political stability of the whole CMEA.*

THE INTERFUEL AND SECTORAL CONTEXT

Beyond their higher calorific content and greater transportability, petroleum and natural gas also effect large savings over solid fuels in virtually all fields of use because of their greater flexibility, combustion efficiency, cleanliness and convenience. This savings, however, is far from uniform. The advantage of petroleum and natural gas over coal (and lignite, peat and shale) under boilers is much more modest than the advantage of these fuels in more specialized furnace uses, while most of the demands of the transportation sector and other mobile demands are technologically tied to petroleum. On the export market, the prices of oil and gas on an even calorific

basis are far higher than the price of coal. Soviet planners have always regarded the burning of petroleum products under boilers and even in furnaces as wasteful. Although it is not relevant for the crucial transport and military markets, natural gas was also somewhat discouraged from boiler uses so that it would be available for the chemical industry, for furnaces, and, to a lesser extent, for family households.

Yet, for geographic reasons, the Soviet Union burns large amounts of oil products and huge quantities of natural gas under power station and industrial boilers. Some 65 million tons of liquid fuels were used in this way at the beginning of this decade.³ Boilers consumed three-fourths of all fuel oil, and, with a few million tons of diesel oil added, this use accounted for about 25 percent of all Soviet petroleum consumption. On a calorific basis, boiler use of natural gas was much larger still, representing over one-half of all demand for this fuel.⁴ In the generation of electricity, which accounts for 75 percent of all boiler use, refinery products and natural gas in 1970 accounted for 48 percent of all fuel consumed in electric stations, and as much as 52 percent in the European provinces of the Russian Republic.⁵ The 1970-1975 plan called for the further growth of this share, and particularly the use of petroleum products, but this plan was formulated before skyrocketing world prices sharply raised the export value of Soviet oil. Improvements in transport technology for natural gas and growing West European interest in gas imports may also have reduced the attractiveness of natural gas for power station use.

The pattern of domestic fuel consumption may well be undergoing a reexamination. There is a renewed interest in lignite development and in fields formerly considered uneconomic; high-level officials are calling for the curtailment of the use of oil prod-

* Council of Mutual Economic Assistance, also referred to as COMECON.

³ Computed from A. S. Pavlenko and A. M. Nekrasov, eds., *Energetika SSSR v 1971-1975 godakh* (Moscow: "Energiia," 1972), pp. 170-71 and Iu. N. Savenko and E. O. Shteingauz, *Energeticheskii balans* (Moscow: "Energiia," 1971), p. 162.

⁴ V. Kudinov and S. Litvak, "O toplivno-energeticheskome balanse," *Vestnik Statistiki*, no. 9 (1972), p. 41. In 1970, consumption of petroleum products (figured as production minus net export) amounted to 375 million tons of standard fuel equivalent. *Narkhoz SSSR v 1973 g.*, p. 258 and *Vneshniiaia trgovlia SSSR za 1970 god* (Moscow, 1972), pp. 26 and 39. The calorific values normally used in Soviet sources for conversion to standard fuel are (in kcal per physical ton): petroleum: 10 million, natural gas: 8.8 million, hard coal: 7 million.

⁵ Kudinov and Litvak, *op. cit.*, p. 41 and Pavlenko and Nekrasov, *op. cit.*, pp. 171-73.

ucts and even gas under boilers.⁶ The U.S.S.R. has also plunged into a sharply accelerated construction program for nuclear plants in its energy-short western regions.⁷ The increase in the use of hydrocarbon fuels under boilers may stop and more oil may even be freed for export. However, for reasons that lie in the geography of demand and supply, it is doubtful that it will be possible to cut down sharply on the consumption of petroleum or of natural gas in the production of steam and electricity in this decade. In the longer run, the growing contribution of atomic power and the belated arrival of really massive supplies of Siberian natural gas may indeed eliminate the need to use oil under boilers. But by then, domestic and East European demand for oil in other sectors will have expanded greatly.

THE GEOGRAPHIC CONTEXT

The importance of geography becomes clear when we realize that Soviet planners must match demand and supply over an area larger than North America (north of Panama), with a population of more than 250 million. With the European CMEA countries, this realm is three times the size of the continental United States and has 361 million consumers. The lack of suitable, long-distance waterways for bulk transport forces full-scale dependence on transcontinental pipelines and railway hauls. Petroleum and gas from West Siberian and Central Asian wells are now piped some 1,500 to 2,000 miles to major Soviet consumer points; crude oil already moves 1,000 miles further west to East European cities, and the huge pipelines under construction for the export of gas will be just as long. Large quantities of Kuzbas coal are railed some 1,500 to 2,000 miles to European Russia or exported to Japan through Pacific ports (3,600 miles away).

From the perspective of the energy economy, the Soviet Union consists of three very different worlds, containing several dissimilar regions.

⁶ See for example V. Kirillin, "Energetika—problemy i perspektivy," *Kommunist*, no. 1 (January, 1975), pp. 46–47 and M. Pervukhin, "Energeticheskie resursy SSSR i ikh ratsional'noe ispolzovanie," *Planovoe khoziaistvo*, no. 7 (July, 1974), pp. 18–19.

⁷ T. Shabad, "News Notes," *Soviet Geography: Review and Translation* (henceforth SG:RT), vol. 15, no. 8 (October, 1974), pp. 518–21. J. Wilczynski, "Atomic Energy for Peaceful Purposes in the Warsaw Pact Countries," *Soviet Studies*, vol. 26, no. 4 (October, 1974), pp. 568–90. O. A. Kibal'chik et al., *Geografiia stroek deviatoi piatiletki* (Moscow: "Prosveshchenie," 1973), pp. 9–15 and Pavlenko and Nekrasov, *op. cit.*, pp. 128–42. The newest Soviet atomic reactors of the water-cooled, graphite-moderated channel type have a capacity of 1000 megawatts. West of the Volga, nuclear plants today can reportedly produce electricity cheaper than conventional thermal plants burning any kind of fuel. By the end of this year, between 8 and 9 million kilowatt nuclear capacity should be in operation, while an East European source quotes 30 million kilowatts as the projected Soviet nuclear capacity in 1980. *Figyelő* (Budapest), no. 8, February, 1974, p. 4.

Soviet Asia, twice the size of the continental United States, boasts nine-tenths of the country's potential energy reserves and vast stores of most other minerals. Sixty-three million people inhabit Soviet Asia, but only half of them live in Siberia and adjoining North-Kazakhstan, where the bulk of these resources are found. Most potential reserves are inaccessible under conditions of present-day technology, and most of the coal and water power potential may remain so. Still, Soviet Asia, and particularly Siberia, represents the biggest storehouse of usable, untapped energy reserves in the Soviet Union (and possibly in the world), and is the only area of the Soviet Union with a huge energy surplus. Accessibility, however, is not identical with transportability over great distances. Siberia's vast supplies of very cheap lignites and exploitable hydroelectric potentials cannot as yet be made available to energy-deficient areas in Soviet Europe or even in the Urals.

Soviet Asia is a harsh land. This is particularly true of Siberia north of the Trans-Siberian railway, a forbidding region of primeval swamp or continuous permafrost, with annual mean temperature variations of 70° to 90°F, where technology and construction experience from southern provinces do not suffice. Unfortunately, virtually all the petroleum and gas reserves of Siberia are found in this area. The environment, the sparse population and the absence of transportation and communication facilities present formidable obstacles to resource exploitation here, as they do in the North American Arctic.

Despite decades of efforts to promote migration to the East, the European U.S.S.R., (with the Urals and the Caucasus) still contains three-fourths of the Soviet population and industry. Its climate, while rigorous, presents no real hindrance to resource development, and it enjoys a transportation and communication network well developed by Soviet standards. The European U.S.S.R. is larger than the rest of Europe and has a considerable range and large reserves of energy (and other mineral) resources. However, these resources have been intensively exploited for many decades, and worsening geological conditions have sharply raised fuel costs in recent years.

More significant for the future, the rapid growth in demand coupled with increasing resource depletion (even the great Volga oil fields have reached the plateau phase), have led to a large energy shortfall in the European U.S.S.R., a deficit that is destined to grow perhaps three-fold in the present decade. Soviet Europe is looking to the Trans-Ural regions for an ever-larger portion of its energy supplies to fill its incremental demand. Further large discoveries, of course, cannot be ruled out. However, in the relatively well-prospected provinces of Soviet Europe, such finds would hinge on a drastic expansion of

very deep drilling, for which the Russians are not yet technologically prepared.

East Europe, more precisely the six bloc countries, is a compact area containing 105 million people. The three northern states are already highly developed, with large metallurgical and heavy chemical industries that are particularly energy-intensive. The region's fuel reserves consist overwhelmingly of coal and lignite; only Romania enjoys substantial, but diminishing, resources of petroleum and gas. The hydraulic potential of the six countries is limited, and can make only an insignificant contribution to the region's energy supply. By 1967, Czechoslovakia and East Germany reached per capita levels of energy consumption that exceeded those in all West European nations, but in large part this was a reflection of an energy structure still dominated by poor quality fuels, with consequent low rates of heat capture.⁸

East Europe imports about one-tenth of its total net energy requirement today.⁹ This share is destined to rise significantly in the future, since the contribution of hydrocarbon fuels in this region is the smallest of all industrialized areas of the world, and must be increased in order to improve the efficiency of East European economies. Excepting Romania, these countries have met all but a small fraction of their petroleum imports by relying on the U.S.S.R. so far; in the last six to seven years, the Soviet Union sig-

nificantly stepped up deliveries and began piping appreciable quantities of natural gas as well.

THE POLITICAL CONTEXT

Political motives interfere much less with economic rationality in Soviet energy decisions today than is popularly supposed. Cost-price considerations and savings from substitution of petroleum fuels in the domestic economy versus the value of hard currency earned from sales abroad, for example, seem to have been the prime considerations behind Soviet oil exports (to the West) in the past. Even the so-called "dumpings" of the early 1960's were of a short duration, for the purpose of breaking into the market. The Soviets were apparently selling well above cost, though—combined with the actions of the independents—their sales contributed to the series of price cuttings, the destabilization of the world oil market and, probably unexpectedly, to the recent actions of the chief oil-producing nations.

Economics and politics are more closely intertwined in Soviet policy toward East Europe's energy needs. The dependence of these countries on Soviet oil, increasingly on gas and, within a decade on nuclear reactors and enriched uranium,¹⁰ clearly constitutes a strong political lever, constantly perceived, whether it is applied or not.** The U.S.S.R. has a clear, long-term interest in both the economic viability and the political stability of these states, and East European leaders have flashed warning signals (i.e., reminders of the Gdansk riots) about danger in the event of a threat to their modest prosperity from the energy front.

Internally, the pace and geography of resource development and the regional distribution and pricing of various fuels follow principles of economic optimization, with little evidence of political interference. Rent payments have been introduced in the mineral industries; production and transport costs are computed with interest charges (though the latter tend to be arbitrary); fuel allocation is aided by linear programming and other algorithms; and prices tend to approximate marginal costs, at least among large areas.¹¹

Political factors may play some role in the struggle over investment funds and the pace of development among the gas, petroleum and coal lobbies. Such struggle is definitely evidenced by large regions. Siberian interests were clearly chagrined in past years by the slow development of the immense lignite fields near Krasnoiarsk. More recently, A. A. Trofimuk, deputy chairman of the Siberian section of the Soviet Academy of Sciences, together with other West Siberian officials, protested vigorously against the decision to shelve earlier plans for the crash exploitation of the super-giant deposits near the Ob estuary and to tap only one field until the end of this decade.¹²

** A political *bon mot* making the rounds in Budapest last summer:

Q: What did we give for the new batch of Soviet oil?

A: Crude White Steel. (The words translate the names of the three liberal Politbureau members just dismissed.)

⁸ J. G. Polach, "The Development of Energy in East Europe," in U.S. Congress, Joint Economic Committee, *Economic Developments in Countries of Eastern Europe* (Washington, D.C.: Government Printing Office, 1970), pp. 367-70.

⁹ Two different sources put the 1970 consumption in the six bloc countries at 456 million tons of SF. The 1973 consumption, therefore, must have fallen between 510 and 520 million tons. *Nafta Broj* (Zagreb), no. 10 (October, 1973), p. 552 and I. D. Kozlov and E. K. Shmakova, *Sotrudnichestvo stran-chlenov SEV v energetike* (Akad. nauk SSSR, Moscow: "Nauka," 1973), p. 25. Production in 1973 can be computed from physical units by calorific equivalents. (See, for example, conversion factors by Polach in reference 8, pp. 352-53.) Output reached about 470 million tons of SF. Data from *Statisticheskii ezhegodnik stran-chlenov SEV* (Moscow: "Statistika,"), pp. 83-84. See also A. F. G. Scanlan, "The Energy Balance of the Comecon Countries," in *Exploitation of Siberia's Natural Resources*, Nato Directorate of Economic Affairs (Brussels, 1974), p. 100. However, Scanlan's figure for the indigenous production of solid fuels is clearly too low.

¹⁰ See Wilczynski, *op. cit.*

¹¹ See for example R. W. Campbell, "Price, Rent and Decisionmaking: The Economic Reform in Soviet Oil and Gas Production," *Jahrbuch der Wirtschaft Osteuropas*, B and 2, 1971, pp. 291-313 and Dienes, *op. cit.*, pp. 14-16.

¹² As quoted in *The Oil and Gas Journal*, September 27, 1971, pp. 49 and 52. For a detailed analysis of the issues and debates connected with the development of Siberian oil and gas resources, see R. N. North, "Soviet Northern Development: The Case of NW Siberia," *Soviet Studies*, vol. 24, no. 2 (October, 1972), pp. 171-99.

The growth of energy consumption in the long run seems closely related to economic development and to the rate of technological advance, but the increase in energy use does not proceed with much regularity through time. Neither does the latter have a systematic relationship to the growth of population, to GNP, or to industry in the short run. Projections of energy demand for individual regions are more difficult still, and decisions concerning the fuel-energy sector are closely intertwined with questions involving the economy as a whole.

During the 1960's, the growth of energy consumption in the U.S.S.R. dropped from the high annual rate of 7.4 percent (prevailing during the previous decade) to 5.1 percent, below the GNP growth rate, and well below industrial growth rates.¹³ Lower rates for energy consumption were made possible by the shift during the 1960's to more efficient fuels and fuel-using processes, such as diesel and electric traction on the railway, substitution of natural gas for

coal in many industrial uses, and the near elimination of firewood from the household sector. However, as a Western authority has written recently:

It seems likely that in the future, the influence of the forces favoring increases in energy requirements per unit of aggregate output may grow relative to the economizing influences. As household incomes rise, and as the Russians permit the growth of the automobile stock [yearly output was to expand from about 200,000 units in the 1960's to over 1.3 million in 1975], income-elastic energy demands will make themselves felt. . . . Many of the biggest economizing possibilities of shifting to better fuels and improving utilization technology are coming to an end [but] the USSR still has a relatively low energy use per capita compared to more advanced countries [less than four-fifths that in the United Kingdom and two-fifths that in the United States].¹⁴

It is reasonable to suppose that domestic energy demand in the Soviet Union during the 1970's will rise at least as fast as GNP and probably faster, and the rate should certainly be above the 5.1 percent of the 1960's. (According to the Soviet handbook, it averaged 5.42 percent between 1970 and the end of 1973.)¹⁵ Four-fifths of all Soviet energy is consumed in the European U.S.S.R., including the Urals and the Caucasus,¹⁶ which increasingly depend on massive transport of fuels from the Asiatic parts of the country. In 1970, consumption in the European provinces already exceeds production by about 140 million tons of standard fuel.¹⁷ Despite the restriction of energy-intensive activities in these regions, even strongly pro-Siberian planners find it inconceivable to believe that the European provinces could account for less than 70 to 72 percent of total Soviet demand by the early 1980's.¹⁸ To keep the deficit from widening, fuel production would have to grow by at least 550 million tons of standard fuel.¹⁹ This is clearly an impossible feat, and economists expect a shortfall of 350 million to 400 million tons.²⁰ Even assuming no further increase in Soviet oil deliveries, close to 95 million tons of standard fuel equivalent of petroleum and natural gas are also evidently committed to East Europe.²¹

A cardinal problem of the Soviet energy economy, therefore, is that of bridging the vast spatial gap be-

(Continued on page 47)

¹³ *Narkhoz SSSR. 1922-1972 gg.* (Moscow, 1973), pp. 61, 126 and 129. Annual rates computed by the compound interest formula. For Western estimates of Soviet GNP and industrial growth see, for example, R. V. Greenslade and W. E. Robertson, "Industrial Production in the USSR," in U.S. Congress, Joint Economic Committee, *Soviet Economic Prospects for the Seventies* (Washington, D.C.: Government Printing Office, 1973), pp. 271-78; and P. G. Peterson, *U.S.-Soviet Commercial Relationships in the New Era* (Washington, D.C.: U.S. Dept. of Commerce, 1972), Annex A, pp. 2, 4 and 11.

¹⁴ R. Campbell, "Siberian Energy Resources and the World Energy Market," in *Exploitation of Siberian Natural Resources*, p. 79. On the growth of automobile industry see I. U. Edward, "Automotive Trends in the USSR," in *Soviet Economic Prospects for the Seventies*, pp. 291-314.

¹⁵ *Narkhoz SSSR v 1973 g.*, p. 62.

¹⁶ Kudinov and Litvak, *op. cit.*, pp. 36 and 42.

¹⁷ A. E. Probst, "Puti razvitiia toplivnogo khoziaistva SSSR," *Voprosy ekonomiki*, no. 6 (1971), p. 55.

¹⁸ A. E. Probst, *Voprosy razmeshcheniia sotsialisticheskoi promyshlennosti* (Moscow: "Nauka," 1971), pp. 218-19.

¹⁹ Consumption in 1970 reached roughly 900 million tons of SF (80 percent of the Soviet total of 1117.9 million) *Narkhoz SSSR. 1922-1972 gg.* p. 61. Production thus amounted to about 760 million tons. Assuming that total Soviet fuel use will increase by no less than 69 percent (corresponding to an annual rate of 5.4 percent) and assuming that no less than 71 percent of all consumption will take place in the European parts and the Urals, the latter regions should need 1350 million tons of standard fuel. This projection is actually lower than that given by Probst in reference 18.

²⁰ Probst, *Puti razvitiia* . . . , p. 55 and *Voprosy razmeshcheniia* . . . , p. 240.

²¹ Soviet oil deliveries to East Europe in 1973 soared to well over 50 million tons. The Druzhba pipeline, serving the four northern states, is being expanded to a capacity of 50 million tons per year, while Bulgaria continues to receive oil by sea. *The Petroleum Economist*, March, 1974, p. 99; *The Oil and Gas Journal*, October 16, 1972, p. 96. Pipelines under construction for natural gas are envisaged to deliver 21.4 billion cubic meters and 15.5 billion are firmly committed from the Orenburg field alone. Moscow Narodny Bank, *Press Bulletin*, June 19, 1974, pp. 4-5 and *Esti Hirlap* (Budapest), July 3, 1974, p. 1 and *The Financial Times* (London), January 24, 1975, p. 4.

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"... the OECD nations outside North America are very much dependent on energy imports. Over the next decade, they must decide on the amount and kinds of international cooperation on energy matters they are willing to undertake."

The Energy Needs of West Europe, Japan and Australasia

BY ELEANOR B. STEINBERG
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MOST OF THE developed, non-Communist economies outside North America have consumed more energy than they have produced for well over two decades. In 1972, Japan, Australia, New Zealand and the countries of West Europe, whose combined populations accounted for 13 percent of the total world population,¹ accounted for 30 percent of total world energy consumption.² As a group, these countries produced only 9 percent of the total world energy output that year; and 57 percent of their total energy consumption was imported.³ In the next 10 or 15 years, they will probably continue to require a great deal more energy than their resource base will permit them to produce.

However, because of important changes in resource development and consumption patterns, some countries may become less dependent on imported energy. Because of their widely diverse energy consumption patterns and resource bases, these countries will be broken down into three groups for purposes of this analysis.

WESTERN EUROPE

Energy production in West Europe appears to be on the verge of significant expansion, primarily because of the discovery of oil and natural gas in the North Sea and the possibility that nuclear power may at last begin to make a substantial contribution to energy production. Estimates of North Sea oil and

natural gas reserves vary widely.⁴ On the basis of conservative estimates made by the Organization for Economic Cooperation and Development (OECD), West European oil production (400,000 barrels daily in 1972) can be expected to rise to over 4 million barrels daily by 1980 and may rise to 6 million barrels by 1985, largely because of expanded output in the North Sea.⁵ Natural gas production, which in 1972 amounted to approximately 2.5 million barrels daily in oil equivalent (largely from onshore gas fields in the Netherlands, where natural gas reserves are declining rapidly), may reach around 4 million barrels daily of oil equivalent in 1980 and 6 million barrels a day in 1985,⁶ as the output of North Sea gas expands.

While all the oil produced from the North Sea will not automatically be consumed in Europe, the governments of the United Kingdom and Norway (the countries that control the North Sea reserves) strongly influence production and export policies and can earmark this oil for European consumption if they so choose. The natural gas, which moves by pipeline, will be consumed in West Europe because it would be extremely uneconomic to transform it into liquefied natural gas (LNG) and export it by ship.

The prospects for increased energy production in OECD Europe, combined with somewhat reduced rates of growth of consumption (stimulated partly by the vast increases in energy prices in 1974), suggest that, by 1980 and 1985, Europe will be somewhat more self-sufficient in energy. Table 1 shows energy consumption and production by major sources of energy in OECD Europe in 1972, and forecasts for 1980 and 1985.

The projections for 1980 and 1985 are, like all forecasts, extremely tenuous because they are based on various premises, any of which can change and thus alter the outlook. For example, the forecasts are based on the assumption that crude oil and other

¹ International Bank for Reconstruction and Development, *World Bank Atlas* (Washington, D.C., 1974).

² United Nations, Department of Economic and Social Affairs, Statistical Office, *World Energy Supplies 1969-1972*, series J, no. 17 (New York, 1974).

³ *Ibid.*

⁴ See for example, *Oil and Gas Journal*, December, 1973; and Peter Odell, "Indigenous Oil and Gas in Western Europe," *Energy Policy*, vol. 1, no. 1, 1973, p. 49.

⁵ OECD, *Energy Prospects to 1985*, vol. 2 (Paris, 1974), p. 94.

⁶ *Ibid.*, Table 6C-1, p. 142.

Table 1. Energy Production and Consumption in OECD Europe by Source of Energy in 1972 and Forecasts for 1980 and 1985.

(in thousands of barrels per day of oil equivalent)^a

Energy Source	1972		1980		1985	
	Total Consumption	Indigenous Supply	Total Consumption	Indigenous Supply	Total Consumption	Indigenous Supply
Oil	14,687	398 (2.7%)	15,694	4,762 (30.3%)	19,435	6,030 (31.0%)
Natural Gas	2,362	2,263 (95.8)	6,613	5,126 (77.5)	8,744	6,332 (72.4)
Coal	5,164	4,625 (89.6)	5,819	4,623 (79.4)	6,000	4,945 (82.4)
Nuclear	332	332 (100.0)	2,388	2,388 (100.0)	5,493	5,493 (100.0)
Hydro and Geothermal	722	722 (100.0)	872	872 (100.0)	985	985 (100.0)
Total	23,266	8,339 (35.8)	31,386	17,752 (56.6)	40,656	23,784 (58.5)

^a For purposes of comparison, all forms of energy have been converted through their respective heat contents into a uniform unit known as oil equivalent.

Note: Figures in parentheses are the percentage of total consumption provided by indigenous supplies—i.e., the second column divided by the first for each year.

Source: OECD, *Energy Prospects to 1985*, vol. 2 (Paris, 1974), Tables 2D-10 2D-11, and 2D-12, pp. 23–25.

energy prices prevailing at the end of 1974 will be maintained in real terms through 1985. The estimates of total energy consumption are based in part on a general forecast of a 5 percent annual rate in economic growth for the region for 1975–1980 and a slightly lower rate for 1981–1985.⁷ A substantial change in the economic outlook and in the price of energy sources could alter total energy demand.

Another cause of uncertainty is the fact that estimates of “regional” (i.e., indigenous) resources can change markedly, particularly with respect to oil and gas, as drilling continues in the North Sea and other offshore areas. In addition, there is uncertainty about the rate of resource exploitation and development. For example, Norway, a small country, cannot possibly consume all the oil that can be produced from its sectors in the North Sea. An unresolved debate within Norway is whether to develop oil and gas resources at the maximum feasible rate and export a large proportion of them (in the hope that the high oil prices of 1974 and 1975 will continue in the 1980’s), or to develop the resources more slowly, thereby extending their lifetime. Moreover, there is concern in Norway about the social impact of rapid development of these energy resources.⁸

Nuclear power is another energy source whose rate of development is highly uncertain. Here the

uncertainty is not resource availability, although uranium resources in Europe are small and cannot fulfill the region’s growing requirements. Worldwide exploration for uranium resources is in the pioneering stage and, while ultimately recoverable reserves are not known, uranium availability is not expected to be a constraint for at least the next 15 years. The major constraints to the rapid development of nuclear power have included serious technical problems in reactor operations, public concern over the safety, health, and environmental consequences and costs (especially before the world oil price increases of 1973–1974). If additional nuclear plants are brought into use more slowly than is indicated by the estimates in Table 1, increases in coal or oil consumption for the generation of electricity can be expected.

Besides the question of how much of West European energy requirements must be provided from resources outside the region, there is also the question of the proportion of total world energy production consumed in West Europe. In 1972, OECD Europe comprised about 10 percent of the total world population and consumed about 23 percent of world energy consumption.⁹ Estimates from various sources suggest that West European energy consumption as a percentage of total world consumption will not change much over the next decade.¹⁰ However, as European population growth rates decline relative to rates in other regions, per capita energy consumption may rise faster than in countries with higher birth rates.¹¹

JAPAN

Japan possesses very little in the way of non-renewable domestic energy resources. The country’s oil, gas and uranium resources are negligible. Japan’s only purely domestic energy resources of any significance are hydraulic power, which provided 2 percent of total Japanese energy consumption in

⁷ *Ibid.*, vol. 2, Table 2-1, p. 43.

⁸ “Norway Reining N. Sea Exploration, Development Work,” *Oil and Gas Journal*, March 18, 1974, p. 27.

⁹ *World Bank Atlas* (1974) and *World Energy Supplies 1969–1972*, *op. cit.*

¹⁰ Estimates for West European energy consumption for 1985 are from Table 1. Estimates of total world energy consumption are based on an assumed annual rate of growth of about 4.7 percent between 1972 and 1985.

¹¹ United Nations, Economic and Social Affairs Department, Population Studies, no. 53, *World Population Prospects as Assessed in 1968* (New York, 1973), Table A.1, p. 63.

Table 2. Energy Production and Consumption in Japan by Source of Energy in 1972 and Forecasts for 1980 and 1985.

(in thousands of barrels per day of oil equivalent)^a

Energy Source	1972		1980		1985	
	Total Consumption	Indigenous Supply	Total Consumption	Indigenous Supply	Total Consumption	Indigenous Supply
Oil	4,933	14 (0.3)	7,747	60 (0.8)	9,160	16 (0.2)
Natural Gas	80	54 (67.5)	683	60 (8.8)	941	145 (15.4)
Coal	1,150	378 (32.9)	1,417	318 (22.4)	1,865	318 (17.0)
Nuclear	46	46 (100.0)	714	714 (100.0)	2,044	2,044 (100.0)
Hydro and Geothermal	189	189 (100.0)	209	209 (100.0)	231	231 (100.0)
Total	6,398	681 (10.7)	1,0770	1,361 (12.6)	14,241	2,898 (20.4)

^a For purposes of comparison, all forms of energy have been converted through their respective heat contents into a uniform unit known as oil equivalent.

Note: Figures in parentheses are the percentage of total consumption provided by indigenous supplies—i.e., the second column divided by the first for each year.

Source: OECD, *Energy Prospects to 1985*, vol. 2 (Paris, 1974), Tables 2D-10, 2D-11, and 2D-12, pp. 23–25.

1973, and low-grade deposits of coal, which fulfill about one-third of Japan's total coal requirements.¹² (See Table 2.) Nearly all the rest of Japan's total energy requirements are imported.

Of the sources of energy in commercial use today, nuclear power is the only domestically produced form of energy that can be expanded significantly.* In Japan, as in West Europe, nuclear power is really only a "quasi-domestic" source. While Japan has the industrial and technological capacity to build nuclear reactors and is developing the capability to manufacture nuclear fuels, the uranium needed for the fuel must be imported, as is true in West Europe. While Japan's Atomic Power Commission has ambitious plans for expanding nuclear power, the government's plans have run into strong public opposition. Memories of the atomic bombs dropped on Japan in World War II persist, and deep concerns about the possible environmental, health and safety hazards of nuclear power plants have made finding acceptable sites for those power plants exceedingly difficult. Nuclear power expansion has been delayed repeatedly; in 1973, this source of energy accounted for less than one percent of total energy consumption.¹³ Despite the Arab oil embargo of 1973–1974 and the vast increases in the price of oil, the extent to which Japan's nuclear power sector actually will be extended by the mid-1980's is an open question.

* The potential sites for installing hydroelectric power plants are more or less fixed in any given country, and in Japan the possibilities for expanding this energy source are very limited.

¹² The British Petroleum Company Limited, *BP Statistical Review of the World Oil Industry, 1973* (London, 1974), p. 16.

¹³ *Ibid.*

¹⁴ Japan Economic Research Center, Institute of Energy Economics "Japan's Energy Problems" (a report to the Brookings Institution) (August, 1973), p. 6.

With relatively meager hopes of greatly expanding domestic energy production over the next ten years, Japan's principal means of controlling her dependence on the energy resources of other regions is by reductions in the rate of increased energy consumption. In the years 1962 through 1971, Japan's energy consumption grew at an average rate of 11.9 percent a year, while real gross national product expanded at a slightly lower rate.¹⁴ Even before the Arab oil embargo and the subsequent large increases in the price of oil, Japan's rate of economic growth had been expected to decline for the remainder of the 1970's to around 8 percent per year. Energy consumption had been expected to grow at approximately the same rate.

In the wake of the fourfold increases in world crude oil prices in 1973–1974, in 1974 Japan experienced her first year of negative economic growth since World War II. The real rate of economic growth in 1975 and 1976 is expected to be considerably below the trend of 8 percent for the 1970's. A reduced growth rate of energy consumption seems likely, largely because of lower expectations about overall economic growth, and also because of a lowering of the rate of energy consumption per unit of economic output in response to sharp increases in the price of oil and other energy. A highly industrialized country, with a large proportion of "energy-intensive" industries, Japan has strong incentives to conserve energy and to use it efficiently. The manufacturing sector, in particular, should be able to reduce its energy use without having to reduce output.

Table 2 shows Japan's pattern of energy consumption in 1972 and her prospects for 1980 and 1985. These forecasts, like those for OECD Europe in Table 1, are based on the assumption that world crude oil prices prevailing at the end of 1974 will be

maintained through 1985. If the oil price increases of 1974 had not taken place, Japan's total primary energy consumption in 1985 was expected to have been approximately 850 million tons of oil equivalent, as compared with the estimate of slightly over 700 million tons of oil equivalent shown in Table 2.**

The table suggests that Japan's dependence on energy imports may decline from roughly 90 percent in 1972 to 80 percent by 1985. Most of the increase in domestic energy is expected to come from a sharp rise in nuclear power between 1980 and 1985, which may or may not be realized. In addition to a significant increase in nuclear power, the table also indicates rising consumption in other non-oil forms of energy, which stems from government policy to diversify sources of supply in order to reduce dependence on oil.

AUSTRALASIA

Australia and New Zealand are, of course, much smaller in terms of population and gross national product than the other two regions considered here. Australia is the only country in the three regions that at present is a net exporter of energy; this position may well continue into the 1980's. Possessing substantial quantities of coal and uranium reserves, Australia has been exporting to Japan and elsewhere for a number of years.

Australia produced and exported natural uranium for a relatively brief period in the 1960's. Production was discontinued in response to the slump in world demand for uranium, which resulted from the worldwide failure of nuclear power to expand as rapidly as had been widely predicted during the 1950's and early 1960's. As nuclear power expands, Australia will in all probability become a major world exporter of natural uranium and possibly nuclear fuels as well. Australia now produces about half her oil requirements, but this proportion will decline in a few years unless more oil is discovered.

New Zealand at present supplies about half of her energy requirements through domestic supplies of coal and hydroelectric power. By 1985, with increased output from these two energy sources plus natural gas, New Zealand may be providing roughly two-thirds of her energy needs.

The OECD countries as a group (excluding North America) are and will continue for the rest of this century to be very much dependent on energy

resources from other regions of the world. Access to energy is vital to the functioning of their industrialized economies and to their high living standards. They are thus very vulnerable in periods of energy shortages. They share this vulnerability with the non-oil-exporting developing countries, the vast majority of which have scant domestic energy resources. Yet this group of OECD countries is in a far better position than the poorer countries to compete in world markets for the energy that is available when supply is tight and/or prices are high.

As the world's petroleum and natural gas resources become increasingly depleted—perhaps in the early part of the next century—the OECD countries will share with all other countries (including the energy-rich nations of today) the need to derive an increasing proportion of their energy requirements from renewable sources like solar energy, geothermal energy, and controlled nuclear fusion.

Given their high dependence on imported energy and the uncertainty about the reliability of their supplies, Japan and Western Europe face a number of policy decisions that may affect their economic well-being for the remainder of the present decade and through the 1980's. One of the most important decisions concerns cooperation on energy matters with each other and with other countries.

While economic interdependence among nations is a concept that governments generally recognize in principle, nationalism is a strong force, and the notion of "going it alone" persists. Nevertheless, in the wake of the Arab oil embargo of 1973–1974, the countries of OECD Europe (except France), Japan, Australia and New Zealand joined the United States and Canada in forming an International Energy Agency.¹⁵ The scope for international cooperation within this new agency is broad, and cooperation on energy conservation has been one of the agency's primary concerns. Furthermore, it is possible that multinational efforts can explore and develop known but largely untapped energy sources, like the Canadian tar sands and the Venezuelan tar belt, to develop a commercially viable technology for coal gasification or liquefaction, and to undertake joint research efforts on new energy sources for the future. Whether the members of the International Energy Agency will actually implement long-range programs of this nature, or whether they will confine themselves to planning for cooperation during emergencies like a renewed Arab oil embargo, is unclear. Yet this de-

(Continued on page 51)

** If the price were to decline in real terms over the next ten years, it is likely that energy consumption (particularly oil) would rise. However, if a "conservation ethic"—stimulated by the steep increases in the world market price for crude oil in 1974 and the psychological shock of the Arab supply restriction in 1973–1974—takes root in Japan, energy consumption will not return to pre-1974 trends.

¹⁵ *The New York Times*, February 16, 1975.

Eleanor B. Steinberg is a co-author, with Joseph A. Yager, of *Energy and U.S. Foreign Policy* (Cambridge: Ballinger, 1974) and with Edwin T. Haefele, of *Government Controls on Transport: An African Case* (Washington, D.C.: Brookings, 1965).

"... the developing countries as a group are more dependent on oil than the rest of the world."

The Oil-Dependent Developing Countries

BY HELEN C. LOW

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TWO-THIRDS OF THE world's people consume only about 15 percent of the world's total commercial energy consumption. The United States alone, with only six percent of the world's population, consumes twice as much energy as the entire developing world. Viewing energy use as central to economic growth—the process by which human energy is matched with higher ratios of tools and techniques to mobilize and convert resources for man's use—the developing countries are concerned that the world's readily accessible, and hence relatively inexpensive, fuel supplies will have been squandered before they are in a position to utilize these supplies fully in the development of their economies.

The world has consumed energy at an accelerating pace, the rate almost tripling in the period between 1950 and 1970. In 1950, only 2.6 billion tons of coal equivalent of energy was expended, compared with 7.2 billion tons in 1970. Ninety-seven percent of industrial energy consumption came from fossil fuels; only three percent came from hydro, nuclear and other sources. The urgency felt by developing countries in staking an increased claim to energy resources rises out of a recognition that, as fossil fuels are being depleted, they are becoming more and more expensive to exploit. A discussion in terms of advanced techniques to permit the extraction of oil from deep ocean floors or to enrich uranium from

low-grade ores tends to overlook the basic question of how much energy is expended to make the incremental energy available.

In many cases, more energy may be used up than is gained,¹ as, for example, in the extraction of oil from shale, or in the use of steam to increase the recovery rate from oil fields. In the escalation of costs resulting from the progressive exhaustion of more accessible reserves, countries with limited financial resources will be left further and further behind in development.

The other key element in the concern of developing countries is that no ready replacement for finite fossil fuels is expected in the foreseeable future. At best, nuclear fission is not likely to supply much more than one-fourth of the world's total energy needs by the year 2000 and, in the opinion of many, its use continues to pose fundamental problems. Nuclear fusion and large-scale solar energy development are still in the conceptual stage. The developing countries can make little contribution to the massive research efforts that must be mounted to develop these resources.

At the other end of the scale of research and development is the developing countries' belief that scant attention is being given to the diffuse energy needs of the large part of their population whose principal fuel is firewood. For example, it is estimated that 58 percent of the energy consumption in India in 1970–1971 came from noncommercial sources and that two-thirds of this was firewood and charcoal.² Research at the level of adapting small-scale projects like windmills, methane tanks and small solar devices to local conditions would greatly benefit many people.³

The developing world encompasses a wide spectrum of economies, ranging from those in which a large portion of the population lives for the most part predominantly outside the monetary sphere to those that have rapidly burgeoning and increasingly complex industries. Many developing economies have

¹ For a discussion of net energy yields, see Wilson Clark, "It Takes Energy To Get Energy: The Law of Diminishing Returns Is in Effect," *Smithsonian*, vol. 5, no. 9 (December, 1974), pp. 84–90. See also Amory B. Lovins, "World Energy Strategies," *Bulletin of the Atomic Scientists*, vol. 30, no. 5 (May, 1974), pp. 302–12.

² P. D. Henderson, *India: The Energy Sector* (Washington, D.C.: World Bank, 1975), pp. 27, 180.

³ See B. H. Billings, "A Proposal to the United Nations Environment Programme for a Programme in Non-Polluting Energy," prepared for the Advisory Committee on the Application of Science and Technology to Development, Twentieth Session, Geneva, October 21 to November 1, 1974 (E/AC.52/XX/CRP.7).

substantial elements of both a subsistence and a modern sector, but the proportions differ so widely that generalizations are difficult. As a whole, developing countries are at a stage in which greater amounts of energy input are demanded for each increment in the growth of the national product than is the case in industrial countries. According to one estimate, in developing countries for each 10 percent increase in GNP, a 13 to 16 percent increase in energy use is demanded generally, compared with a 9 percent average increase in energy demand in industrial countries.⁴ Moreover, while countries like the United States can seriously contemplate a zero energy growth rate without a decrease in the standard of living⁵ through the use of available and projected technologies and a realignment of priorities, such a proposal is not feasible for a developing country that has not yet moved very far in terms of utilization of its resource base.

ENERGY SOURCES AND USES

Energy consumption in the developing countries, including Communist Asia, grew from 9 percent of the world total in 1950 to almost 16 percent in 1970. During this time, these countries' share of the world population increased from 67 to 70 percent. The rate of increase in per capita energy use has varied among regions, ranging from an average of 3 percent in Africa to 3.4 percent in Latin America to 5 percent in non-Communist Asia during the 1960's, compared with 4.2 percent in the United States. Petroleum accounted for almost 64 percent of the energy consumed by non-OPEC developing countries in 1972, coal for 22 percent, natural gas for over 10 percent, hydroelectric power, nuclear power and imported electricity together for less than 4 percent of the total. This marked a significant change from

1961, when petroleum contributed 57 percent and coal 32 percent.⁶ This pattern of fuel source in the developing countries differs notably from that of the world as a whole, which, in 1971, used petroleum for 44 percent of its needs and coal for 33 percent.⁷ A comparison of the two indicates that the developing countries as a group are more dependent on oil than the rest of the world—a fact that accentuated the impact of the 1973–1974 oil price increase on their economies.

Energy consumption varied widely among the developing countries in 1971, reflecting a broad spectrum of resource endowment and differing degrees of resource utilization. On a per capita basis, consumption ranged from 11 kilograms and 13 kilograms of coal equivalent in countries such as Burundi and Upper Volta to 1,270 kilograms and 1,773 kilograms in Mexico and Argentina respectively.⁸ Such a figure does not represent the consumption of the average person but indicates the level of commercial energy use in the economy. (Thus Surinam, for example, shows a consumption rate of 2,229 kilograms, reflecting the use of energy in the processing of bauxite.)

Table 1 shows the rates of growth of national product, population and energy consumption during the decade of the 1960's for 17 countries with widely differing economic situations. Fifteen of these are energy-dependent countries (the varying extent of dependence being apparent from a comparison of net energy imports with total energy consumption). Indonesia and Nigeria, both OPEC members, have been included to point out that, in terms of the level of national product and energy consumption on a per capita basis, they face the same challenges as those of the lowest per capita income group. While oil is plentiful, it has not yet been widely used within the domestic economy, per capita consumption being 59 kilograms of coal equivalent for Nigeria and 123 kilograms for Indonesia in 1971. Their immediate concern is to utilize the revenues from limited oil reserves (22 years for Indonesia and 27 years for Nigeria at 1973 rates of extraction)⁹ to build a sound base for the continued development of their economies.

Meaningful analysis of energy sources and uses must focus on the circumstances within a given economy. With roughly a hundred to choose from, four have been selected here¹⁰ to illustrate the range of profiles of economic activity and the dynamics of energy utilization.

Niger. Nearly one-third of Niger's people are nomadic; the rest depend heavily on agriculture in the limited zone of arable land. The country was badly damaged by the Sahelian drought, which is estimated to have reduced the population by almost one million people to a level of about 3.5 million. Agricultural production was disrupted by this catastrophe, and 80

⁴ Sam Schurr, ed., *Energy, Economic Growth and the Environment: Resources for the Future* (Baltimore: Johns Hopkins University Press, 1972), pp. 182–183.

⁵ Energy Policy Project of the Ford Foundation, *A Time to Choose: America's Energy Future* (Cambridge, Mass.: Ballinger Publishing Co., 1974), chapter IV.

⁶ James W. Howe and the staff of the Overseas Development Council, *The U.S. and the Developing World: Agenda for Action, 1974* (New York: Praeger Publishers, 1974), Table C-1, p. 174. See also *ibid.*, *The U.S. and World Development: Agenda for Action, 1975* (New York: Praeger Publishers, 1975), p. 214.

⁷ Derived from United Nations, Department of Economic and Social Affairs, *World Energy Supplies, 1961–70 and 1968–71*, Statistical Papers, Series J, no. 15 and no. 16 (New York).

⁸ United Nations, *Handbook of International Trade and Development Statistics: Supplement 1973*, Publication Sales No. E/F.74.11.D.7, pp. 102–115.

⁹ Howe, *op. cit.*, p. 241.

¹⁰ The figures concerning these four countries have, unless otherwise noted, been drawn largely from Arthur D. Little, Inc., *An Overview of Alternative Energy Sources for LDC's*, a report to U.S. Agency for International Development, August 7, 1974.

Table 1. Growth Rates of Population, GNP and Energy; Energy Consumption and Imports for Selected Countries

Countries	GNP per capita 1972 (\$ m)	Popula- tion growth rate 1960- 1970 (%)	GNP growth rate 1960- 1970 (%)	GNP Growth Rate per capita		Energy Consump- tion per capita 1971 (kgs. of coal equiva- lent)	Energy Consump- tion growth rate (%) 1960-1971	Energy Consump- tion 1971 (million metric tons)	Energy Net Imports 1971 (million metric tons)
				1960- 1970 (%)	1965- 1972 (%)				
Bangladesh	70	2.6	4.2	1.6	-1.6	35 ^c	5.8 ^{ac}	10.8 ^{ac}	4.9 ^a
Pakistan	130	3.2	7.2	3.9	1.7	139 ^f	5.8 ^{ac}	10.8 ^f	4.9 ^a
Brazil	530	2.9	6.0	3.0	5.6	515	7.0 ^b	49.5	25.5
Chile	800	2.2	4.4	2.2	2.2	1487	7.3 ^c	14.8	4.9
Costa Rica	630	3.3	6.2	2.8	4.1	448	11.2	.8	.5
Dominican Republic	480	2.9	5.2	2.2	5.0	255	7.7 ^c	1.1	1.1
Ghana	300	3.0	2.1	-0.9	1.0	186	8.2	1.6	1.2
India	110	2.2	3.7	1.5	1.4	186	4.9	102.7	17.5
Ivory Coast	340	3.4	8.1	4.5	4.1	282	17.1	1.2	1.0
Kenya	170	2.9	5.6	2.6	4.1	172	5.3	2.0	1.3
Korea	310	2.4	8.7	6.2	8.5	860	14.3	27.9	14.7
Niger	90	2.9	3.2	0.3	-5.1	25	18.3 ^d	.1	.1
Philippines	220	3.0	5.7	2.6	2.4	292	10.0 ^e	11.1	10.3
Sri Lanka	110	2.4	4.4	2.0	2.0	128	3.9	1.6	1.4
Thailand	220	2.7	8.0	5.2	4.2	312	19.0	11.0	9.9
Indonesia	90	2.6	3.5	0.9	4.3	122	1.4	14.4	-45.24 ^g
Nigeria	130	2.5	4.8	2.2	5.4	59	17.9	3.3	-93.22 ^g

a. Pakistan and Bangladesh together.

b. Grew at 10.7 percent in 1966 to 1971.

c. 1961-1971.

d. 1960-1970.

e. Based on IAEA estimates for early 1970's.

f. Government of Pakistan figures for 1972-73 show 9.9 million metric tons.

g. Negative figures indicate net exports.

Sources: Columns 1 and 4 from *World Bank Atlas, 1974*; columns 2, 3 and 5 from Report by chairman of the Development Assistance Committee, *Development Cooperation: 1974 Review* (Paris: OECD, 1974), table 110, pp. 323-325; columns 6, 7, 8 and 9 from Arthur D. Little, *Overview*, and U.N., *World Energy Supplies, 1971*.

percent of the livestock was obliterated. The small industrial sector of Niger's economy deals mainly with the processing of local products for local consumption. The discovery of high-grade uranium ore in 1967 resulted in mining operations that began production in 1971; an output of 2,000 metric tons is expected in 1975. Further prospecting is actively under way for tin and nickel as well as uranium.

Niger has hardly begun to develop her energy resources nor has she set up institutions to plan an energy program. Virtually all her energy is imported, mostly in the form of petroleum. A few oil-fired plants produce electricity, but because most of them are isolated units, prices tend to be too high for most would-be energy users. The only commercial energy produced from indigenous sources is a small amount of hydro-generated electricity. Very little has been done to supply energy to the rural areas, where it is badly needed to make water available.

Hydroelectric potential, although nominally large

in terms of topography, is limited by the availability of water. Coal reserves, identified by a United Nations-sponsored survey, are now being assessed; coal is the likely fuel source for a second uranium mining operation. While the region looks promising for petroleum, sporadic exploration over the past 20 years has yielded no discoveries; further tests are being undertaken at present. The hot, dry climate of Niger raises the possibility of the exploitation of solar energy, especially for such primary purposes as pumping water from the sub-soil and irrigation. Experiments along these lines were undertaken in the late 1960's under United Nations aegis but have not been actively pursued.

Kenya. In the period 1968 to 1973, the gross national product (GNP) of Kenya grew at a rate of 7.5 percent, well above the general average of developing countries.¹¹ While population was increasing at the very high rate of 3.3 percent, the rate of growth of the national product on a per capita basis was about average for developing countries. Three-fourths of the population was employed in the agricultural sector, which contributed 35 percent of the

¹¹ Statistics and Reports Division, U.S. Agency for International Development, *GNP: Growth Rates and Trend Data by Region and Country*, May 1, 1974, Table 2a, p. 2.

GNP; coffee, beef and tea are the leading commercial crops. Industry, which accounted for 18 percent of the GNP and which was expanding at an annual rate of 7.8 percent, grew most notably in the direction of consumer goods to replace imported items, like textiles, sugar, and tires. In the period from 1960 to 1971, total energy consumption increased at an average rate of 5.3 percent, bringing the level of energy use to 172 kilograms of coal equivalent per person in 1971.

Petroleum and petroleum products (processed at the refinery at Mombasa) accounted for over 90 percent of energy use, all of it imported. The only domestic source of energy was hydroelectric power, which supplied about 2 percent of total energy consumed; the rest of the country's demand for electricity, which was increasing more than 10 percent per year, was supplied from Uganda. By 1980, the demand for electricity is expected to rise to 286 megawatts.

Plans for the development of hydro capacity, set out in 1969 in a 20-year time frame, call for the development of 60 megawatts in six installations on the Tana River with financing from the International Bank for Reconstruction and Development (IBRD, or World Bank). The first of these is producing 44 megawatts, another 30 megawatts was expected in 1974. The entire electrical supply system of the country has been joined from Jinja (in Uganda where the Nile leaves Lake Victoria) through Nairobi to Mombasa, with plans to tap the lines in the surrounding countryside for rural electrification. Oil refining capacity is being enlarged, and an oil pipeline is planned from the port at Mombasa to Nairobi. No breakthroughs have occurred in the search for oil, although prospecting—which had been pursued from 1954 to 1971 without success—has been given new impetus by recent events. Nine companies are currently searching on- and off-shore, spurred by the hope of a promising geological formation.

The possibility of utilizing steam from the Rift Valley is under experiment. A 30-megawatt plant will be built at Lake Naivasha with funding from the World Bank if the scheme proves feasible. Promising studies of the geothermal potential of the region are under way under United Nations auspices. As yet, nuclear power has not been deemed cost-competitive in Kenya.

Brazil. The Brazilian economy grew at an average rate of over 10 percent in the years 1968 to 1973,¹² while population increased at 2.9 percent. Energy consumption more than doubled in the 1960's; in per capita terms, it increased to a level of over 500 kilo-

grams in 1971. The structure of the economy changed significantly: manufacturing grew from 19 percent to over 25 percent of GDP from 1952 to 1971, while agriculture moved inversely. The pattern of industry shifted; textiles and food processing accounted for a smaller proportion of the total, while chemicals, basic metals and heavy industry, like automobile production, increased substantially.

Ignoring firewood, which is estimated to account for more than half the total energy consumed in Brazil, three-fourths of the commercial energy consumed was petroleum, over 10 percent was hydro and nuclear power, 10 percent was coal, and 3 percent was natural gas. Over half the petroleum was used by the transportation industry, since trucks carry half of the freight within the country. Industry accounted directly for another fourth, while one-tenth went to households. Brazil's consumption of petroleum is increasing considerably faster than her production despite expanded exploration; the proportion imported grew from 66 percent in the mid-1960's to 70 percent in 1970 and probably to nearly 80 percent in 1973.

Proven oil reserves amounted to one billion barrels in 1972; recent discoveries have doubled or perhaps tripled this figure. Coal, measured at about 3.3 billion megatons, plays a comparatively insignificant role in the Brazilian energy forecast because of limited reserves and inferior quality. Because coking coal is scarce, imports will continue to be relied upon heavily. Proven natural gas reserves amount to about 5 trillion cubic feet. Oil has been produced from shale in a pilot plant but not commercially; reserves are estimated to contain about one billion barrels. Brazil's hydroelectric potential is considered the greatest in the world. Huge sums have been invested in this field in the past decade, with the result that, in 1971, about 80 percent of Brazil's generating capacity was hydroelectric. Construction is under way on what will be the world's largest hydro facility, shared with Paraguay, on the Parana River.

India. The Indian economy grew at the rate of 3.7 percent in the 1960's, with a rate of 4.7 percent in the late 1960's. The population growth of 2.2 percent absorbed much of the increase. Partly as a result of crop shortfalls, fertilizer scarcity and retrenchments due to the oil price increase, the rate of growth of the economy has been set back; a negligible or even negative per capita rate of growth is expected in the next few years unless substantial external assistance is forthcoming.¹³

About 70 percent of the population is dependent on agriculture. The contribution of agriculture to the national product fell in the 1960's from about 50 percent to less than 43 percent; it dipped still lower before the decline was arrested in mid-decade, largely as a result of government policy. Manufacturing, which grew at a rate of 5.4 percent per year over

¹² *Ibid.*

¹³ See Helen C. Low and James W. Howe, "Focus on the Fourth World," *The U.S. and World Development*, p. 39.

the decade, accounted for over 24 percent of the national product in 1973. Industries producing items like fertilizer, machine tools and electric motors grew at a rate of over 10 percent per year.

As is the case in other developing countries, firewood and cowdung are a principal energy source; and in India, as elsewhere, the resultant deforestation is creating a serious problem of erosion. Consumption of commercial energy grew at a rate of 4.9 percent over the 1960's. The quantity of coal stayed relatively constant, while the share of other fuels increased. Mining and manufacturing accounted for 54 percent of commercial energy use, transport, for 24 percent, and agriculture, less than 5 percent. Household consumption took almost 13 percent, much of which consisted of kerosene for lamps and stoves in rural areas.

Energy produced within the country totaled about 85 million megatons in 1971, virtually the same level as in 1968, with imports covering a 9 percent rise in consumption. Coal production increased slightly over most of the period from 1951. Domestic crude oil production increased from .5 million to over 9 million megatons in the decade 1961-1971, supplying nearly 11 percent of domestic energy production in 1971. Imported petroleum and derivatives accounted for another 19 percent of total consumption. Hydro power accounted for 42 percent of electricity production in 1971, with increasing reliance on this source. The shortage of electrical power is viewed as a major restraint on the growth of both industry and agriculture and is held responsible for many of the shortfalls in reaching targets set out in the current five year plan.

In terms of potential, coal and lignite reserves are considered adequate for 100 years, to be used largely in the thermal power-generating sector; reserves of coking coal, while meager, can probably be stretched to meet steel industry needs for 50 years. Proven reserves of petroleum in 1971 were set at about 174 million megatons—a very small amount at current rates of consumption. Subsequent discoveries in the Bombay High area offshore offer hope of doubling the present production level. The hydroelectric potential is estimated to be capable of providing 2.5 times the present consumption, the basic problems being those of location and site development. Schemes are in progress to utilize about 11.6 million kilowatts of this potential. In the nuclear field, India

has had plants in operation with a total capacity of about 600 megawatts; two more with a total of 1080 megawatts are under construction.

ENERGY POTENTIAL IN DEVELOPING COUNTRIES

A survey of the energy potential of developing countries indicates that a large number of them are energy-poor in terms of known and projected resources. As a whole, the non-OPEC developing countries produce about 70 percent of the petroleum they consume.¹⁴ About a dozen of them, including Angola, Bolivia, Colombia, Congo, Malaysia, Mexico, Peru, and Zaire are virtually self-sufficient, or are net exporters on a small scale. A few others, like Brunei, and Trinidad and Tobago, export significant quantities of oil but are not members of OPEC. (Gabon is an associate member of OPEC.) If the largely oil-sufficient countries are excluded, the remainder, about 80 countries, are heavily dependent on oil imports, which in 1970 accounted for about two-thirds of their consumption. Longer term prospects may be promising for a number of others.

But of the proven global reserves of 627 quadrillion barrels recorded at the end of 1973, only 4.6 percent were located in non-OPEC developing countries.¹⁵ Gas reserves show non-OPEC developing countries accounting for 6 percent of proven world reserves. As for coal, this group accounts for about 10 percent of known reserves. There is a presumption that further exploration will disclose further sizable reserves of all these fossil fuels. Considerable hydro capacity exists in a number of locations but there are serious drawbacks to the usefulness of a substantial portion of the sites.

Nuclear plants are in operation or under construction in several developing countries, those outside the Middle East being Argentina, Brazil, India, Korea, Mexico, Pakistan, Mainland China, and Taiwan. Whether wider use will be made of this energy source in the developing countries in the foreseeable future will depend on a number of factors, including the ability of the country to find financing. It will depend also on the adaptation of plant design to a smaller scale at a cost-competitive price, since only a limited number of countries have industrial concentrations large enough to utilize a nuclear unit of 800 megawatts capacity.

VULNERABILITY OF THE OIL-DEPENDENT COUNTRIES

In 1973, petroleum accounted on the average for 9 percent of the total import bill of the 15 oil-dependent countries shown in Table I; it amounted to \$2.17 billion of a total of \$23.52 billion. In 1974, oil imports accounted for 19 percent of their import bill, or for \$7.77 billion of a total of \$40.58 billion.¹⁶ This represents an increased outlay of \$5.59 billion by

¹⁴ United Nations, Department of Economic and Social Affairs, *World Economic Survey, 1973, Pt. II, Current Economic Developments* (1974), p. 1-42.

¹⁵ Derived from Joseph A. Yager and Eleanor Steinberg of the Brookings Institution, *Energy and U.S. Foreign Policy* (Cambridge, Mass.: Ballinger Publishing Co., 1974), Table A-6, p. 452.

¹⁶ Based on Overseas Development Council staff calculations.

the oil-dependent countries despite curtailed oil purchases. The bill for the non-OPEC developing world as a whole has been estimated to have increased by \$10 billion. The Brazilian representative to the meeting called in Paris in April, 1975, to consider the agenda for an international energy conference stressed the fact that the oil-dependent developing countries had been hurt by the oil price increases, noting that for Brazil, oil imports currently absorb nearly 40 percent of export receipts as compared with 15 percent before the price rise.¹⁷

Instead of lessening over time, the situation for the oil-dependent developing countries is becoming more acute. A number of them (India, Bangladesh, Kenya, Tanzania, Sri Lanka, Sudan and Pakistan being notable exceptions) had accumulated reserves during the buoyant period of rising world prices in the early 1970's, and drew on these to meet the initial oil payments. By 1975, these have largely been depleted, and other cushioning elements like long-term contracts have been phased out, so that the impact is felt more fully.¹⁸ (One source on which 30 developing countries relied for funds was the Oil Facility of the International Monetary Fund, which made available \$1.02 billion at an interest charge of 7 percent.)¹⁹

The worldwide recession, with its depressant effect on the market for developing world exports, has further exacerbated the difficulty. The oil price burden is a significant part of the current account deficits of the oil-dependent developing countries, which are estimated to have risen from less than \$10 billion in 1973 to almost \$24 billion in 1974, and will probably exceed \$30 billion in 1975. When account is taken of the global net impact of the oil price increase over time, the oil-dependent developing countries may bear the long-term brunt of the deficit.

The oil price increase does more than pose difficult problems of financing external deficits. The retrenchment was severely felt, both in the cutback of other imports and in the curtailed use of petroleum products themselves. The Indian government vividly illustrated the internal implications when it pointed out that: a shortfall of 1 million tons of fuel in the agricultural sector would deprive 10 million acres of irrigation, with a resultant decrease in 5 million tons of foodgrain; a shortfall of 1 million tons of fossil fuel in the fertilizer industry would result in the loss of about 8 million tons of foodgrain; a shortfall of 1 million tons of kerosene would leave 50 million rural homes without light; a shortfall of 1 million tons of diesel fuel would decrease the functioning of

transport facilities by 20 percent; a shortfall of 1 million tons of fuel oil to bolster the coal-burning thermal stations would upset all power generation plans.

As a result of the oil price increase, India was forced to reformulate her current five year plan. Kenya lowered the goals of her current plan by one-third. For Sudan, among others, the external debt problem was aggravated. Sri Lanka and Tanzania adopted measures to curtail the less essential uses of oil. Because of the increased cost of nitrogenous fertilizer, produced from petroleum products, the 32 countries singled out by the United Nations as "most seriously affected" by the crisis (most of them in the group of countries with lowest per capita incomes) suffered a shortfall of 337,000 tons of fertilizer and a resultant grain loss of about 7.7 million tons.²⁰

In weighing alternative approaches to meeting energy requirements in ways that leave their economies less vulnerable, developing countries face the dilemma posed by mounting costs for domestically assured supply. Some of them have no viable alternative to continued extensive dependence on the outside world. Many can mitigate this dependency by developing the most promising of their internal sources. But virtually all—except those countries that prove to have adequate domestic petroleum reserves at reasonable costs of exploitation—will remain vulnerable for the foreseeable future. They are acutely aware of the lack of multilateral measures to ensure reliable supplies of fuel at stable prices.

Several considerations highlight the desirability of international coordination of energy policy from the point of view of the developing countries. One is the need for an alternative to continued vulnerability of their economies to disruptions of price and supply, on the one hand, or to an attempt at economic autarchy on energy policy, on the other. Self-sufficiency in energy can prove to be an extremely costly undertaking; it is not a choice open to most developing countries. A second consideration is the need for a long-term and broadly agreed program for the rational use of the world's depletable resources, as seen by those who can least afford to pay more or to do without them. A third factor is the need for coordination of the research and development effort required to achieve a breakthrough to utilization of the nonexhaustible energy resources of the planet. The sooner this is achieved, the sooner the pressure on

(Continued on page 46)

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¹⁷ *The New York Times*, April 8, 1975.

¹⁸ See Low and Howe, *op. cit.*, pp. 44-45.

¹⁹ International Monetary Fund, *IMF Survey*, vol. 4, no. 7 (April 14, 1975), p. 107.

²⁰ International Monetary Fund, *IMF Survey*, vol. 4, no. 4 (February 17, 1975), p. 55.

"Internationally, Peking must seriously consider the desirability of allowing Western technology and capital to enter the country on a larger scale. Domestically, China must consider a wider range of alternatives in economic planning."

China's Energy Resources and Prospects

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IN A WORLD in which the prices and availability of energy products, especially petroleum, are of critical importance to many countries, the recent emergence of China as an oil exporter may have a wide-ranging impact. Large oil-importing countries (notably Japan, in view of her closeness to China) will undoubtedly be influenced in their external economic and political dealings by the prospect of Chinese oil. This, in turn, will affect the trilateral relations among China, the Soviet Union, and Japan and, indirectly, of course, United States-Japanese relations.

From the point of view of a developing country like China, the emergence of a new, major export commodity could significantly relax the balance of payments constraint in the country's economic and political planning. At the same time, the appearance of promising new export opportunities will increase the cost to China of her continued refusal to utilize foreign technology and capital in a manner that could greatly expand oil export, thus speeding-up her own economic development. Furthermore, traditional Chinese exports are rather limited and face relatively inelastic demand. In contrast, the new oil export from China will be far more sensitive to income variations in the rest of the world and, in the longer run, to price changes. These factors will inevitably involve China more intimately in economic fluctuations in other countries should Peking choose to expand its export of oil as much as it seems to have expanded it since 1973. With the appearance of new economic opportunities, the People's Re-

public of China will have to face new and complicated economic problems that do not have very obvious solutions.

To begin with, a few figures are indicative of the order of magnitude involved. One of the most enthusiastic boosters of Chinese oil is Ryutaro Hasegawa, chairman of the board of Asian Oil and principal negotiator with Peking on behalf of the Japan-China Oil Importing Council. According to Hasegawa,¹ Chinese crude oil production in 1973 amounted to 50 million metric tons (the same figure has been given by Chinese Premier Chou En-lai). This may be compared to about 4.5 million tons in 1960 and 18 million to 20 million tons in 1970.² Speaking in March, 1974, Hasegawa estimated Chinese crude production at 70 million tons in 1974 and at 100 million tons in 1975. He speculated that Chinese crude oil production could reach 400 million tons by 1980 if, of course, the necessary technical aid is given by Japan.

Equally rosy estimates come from other Western sources. Writing from New Delhi in March, 1975, Trevor Driberg states in *The Guardian*³ that Chinese crude oil production was expected to reach 77 million tons in 1975, 120 million tons in 1977, and 400 million to 500 million tons in 1980. The fluidity of these estimates is, however, illustrated by Driberg's figure for 1975—25 million tons lower than the figure advanced by Hasegawa, although Driberg's long-term projection for 1980 was considerably higher. Given projected expanded production, the continuous expansion of Chinese oil export is generally expected. According to Driberg, even if Chinese domestic consumption of oil were to double by 1977, the available surplus for export could well be in the neighborhood of 20 million tons, and this amount could readily grow in subsequent years. Earlier, Hasegawa had suggested that Japan alone could import 100 million tons of crude from China by 1980, i.e., 25 percent of Chinese production, at 400 million tons.

These optimistic estimates, based on Chinese announcements of record-breaking production and new

¹ Report in *Sankei* (Tokyo), August 16, 1974. All tonnage figures in this paper are metric tons.

² The estimates of 4.5 million tons for 1960 and 18 million tons for 1970 are given by Robert Michael Field, "Chinese Industrial Development, 1949-70," *People's Republic of China: An Economic Assessment* (Washington, D.C.: The Joint Economic Committee, 92nd Congress, 2nd Session, May, 1972), Table B-1, p. 83. The 20-million-ton figure is used by Vaclav Smil in "Energy in the PRC," *Current Scene*, vol. 8, no. 2, Hong Kong, February, 1975.

³ Trevor Driberg, "China Enters the Oil League," *The Guardian* (Manchester), March 8, 1975.

oil discoveries on land and offshore are, of course, encouraged by the Chinese. Western perception has been further influenced by the oil crisis of the winter of 1973. Full appreciation of the *modus operandi* of Chinese and Japanese diplomacy in oil negotiations between the two countries must include a consideration of the interaction between Sino-Japanese and Soviet-Japanese negotiations.

Japan's diplomatic recognition of Peking took place shortly after the formation of the Kakuei Tanaka government in the fall of 1972. A Japanese delegation headed by Yosamatsu Matsubara, president of International Oil, went to Peking in January, 1973. A second visit took place in March. The delegation successfully arranged for the Japanese import of one million tons of Chinese crude.⁴ Actual import began in May, 1973,⁵ and the projected import by International Oil was 1.5 million tons in 1974.

Earlier, Japan had negotiated with the Soviet Union for future oil imports from Tyumen, along with imports of natural gas from Yakut and oil and gas from Sakhalin, in return for Japanese investment in the further exploration and development of these Soviet sources. The expected volume of Japan's crude oil import from Tyumen was expected to be 40 million tons a year over a 20-year period, beginning from 1978.⁶ This was the Japanese expectation when International Oil first negotiated with Peking in early 1973. In April, 1973, immediately after the announcement of the International Oil's negotiation success in Peking, Idemitsu Kosan was able to contract to import one million tons of Tyumen crude. Shipment by tank car was expected to arrive promptly at Nakhodka, whence the oil would be carried in Japanese tankers to the Tokuyama refinery of Idemitsu. Idemitsu Kosan is one of the principal owners of International Oil. The *Nihon Keizai* commented on April 19, 1973, that the Soviet Union may have been especially anxious to discourage the on-going Sino-Japanese oil negotiations when it agreed to make the oil shipment from Tyumen to Nakhodka by rail.

Only a few months later, not long before the onset of the oil crisis triggered by the Arab embargo, the Soviet Union advised Japan that it would like to reduce future crude export from Tyumen to Japan from 40 million to 25 million tons a year. In addition,

transportation, originally intended to be by pipeline, would be largely by rail. Japanese investment was invited to help construct a second trans-Siberian rail line from Lena City to Komsomolsk on the Amur.⁷ These new proposals were surfaced during negotiations between the two countries in August, 1973; needless to say, they greatly disturbed Japan. The latter was concerned on several counts: the much larger investment involved; the sharply reduced prospects of oil import from Tyumen; the adverse effect of the proposed new railway on the strategic balance between the Soviet Union, on the one hand, and China and Japan, on the other; and, last but not least, fear of an unfavorable reaction from Peking if Japan were to continue her negotiations with the Soviet Union under these conditions.

At about this time International Oil announced its intention to negotiate for an increase of crude oil import from China to 5 million tons during 1974.⁸ The Japanese also revealed that a pipeline linking the Taching oil field—the principal Chinese source of Japan's imported low sulphur oil—and Chinchow in Southern Manchuria had already been completed, and that the extension of this pipeline to Dairen and Chinchuangtao was scheduled for completion at the end of 1974.⁹ The Japan-China Oil Importing Council was formed in March, 1974, as a second negotiating arm for oil import from China. Headed by Hasegawa of Asian Oil, the new organization was composed of 17 oil firms and trading companies.

An announcement of possible large imports of Chinese oil from 1974 on was made by Hasegawa in mid-March. Only one month later, Idemitsu, which had hoped for large Soviet oil imports, was told by the Soviet Union that the promised supply of Soviet crude would be reduced, while the price would be raised to a new high of \$16 per barrel.¹⁰

These developments further intensified Japanese interest in Chinese oil, and China was quick to seize the opportunity. In October, 1974,¹¹ a Chinese oil trade mission to Tokyo reached an agreement with International Oil and the Japan-China Oil Importing Council that the supply of Chinese oil to Japan would be increased immediately during the fourth quarter of that year from the 500,000 tons originally scheduled to 850,000 tons. Total oil imports from China were expected to be 4.5 million tons in 1974 and at least 8 million tons in 1975. There was even talk about 10 million tons of Chinese oil for Japan in April, 1975–March, 1976 (FY1975) in Japan and of a total import of 20 million tons soon after that.¹² Clearly, the Chinese were dangling the promise of potentially large amounts of oil as a bait to Japan. China's reasons were mixed. They included the establishment of closer economic relations with Japan as a political lever, the discouragement of closer Soviet-Japanese relations, and larger foreign ex-

⁴ Report in *Nihon Keizai* (Tokyo), April 18, 1973.

⁵ *Nihon Keizai*, May 14, 1974.

⁶ *Mainichi* (Tokyo), March 14, 1974.

⁷ See *Tokyo Shimbun*, September 11, 1973, the *Yomiuri*, September 5, 8, 1973, and *Asahi*, September 6, 1973.

⁸ *Nihon Keizai*, September 25, 1973.

⁹ *Asahi*, September 15, 1973, and *Nihon Keizai*, September 25, 1973.

¹⁰ *Sankei*, April 14, 1974.

¹¹ *Yomiuri*, October 2, 1974.

¹² *Tokyo Shimbun*, August 30, 1974.

change earnings from oil export. Japanese businessmen involved in trade with China, on the other hand, had their own reasons in the light of the recent oil crisis. Both they and the Japanese government were, of course, interested in using China as a lever in future negotiations with the Soviet Union, which apparently had overplayed its hand. This Japanese interest may have colored, if not deliberately distorted, the Japanese perception of, and public statements about, the volume of oil imports from China that can be expected in the foreseeable future.

Chinese oil export to Japan in significant quantity began in the spring of 1973. It rose to 4 million tons in 1974 and is expected by Japanese importers to reach 8 million tons in 1975. These figures should be closely scrutinized against the available evidence of actual export and production and in the light of China's overall prospects of energy supply and consumption.

Consider first the relationship between China's oil production and export, the bulk of which has thus far gone to Japan. (Export in relatively small quantities has also been sold to Thailand, Hong Kong, the Philippines, Australia, and North Korea and North Vietnam.)

Those who are familiar with Chinese economic development during the last 25 years will recall the steady growth of the economy during the period of the first five-year plan (1953–1957). The Great Leap Forward that followed ended in a great depression within the industrial sector in 1960, following by about a year the collapse of agriculture and the commune movement. Late in 1959, China's largest producing oil field was discovered at Taching. The second major new oil field was opened at Shengli in 1964. In 1964–1965, the Chinese economy finally recovered from its great depression. China's crude oil production in 1966 was estimated at 9 million tons, nearly double the 1961 production. This increase doubtless should be attributed to Taching.

Economic conditions again took a downturn in 1967–1968 as a result of the Cultural Revolution, although a third major new oil field, at Takang, was opened in 1967. By 1967, China's crude oil production had reached 11 million tons, an increase of 2 million tons over the 1966 level. The increase in production up to 1967 should perhaps be attributed mainly to Taching and only secondarily to Shengli.

¹³ See Vaclav Smil, "Communist China's Oil Exports: A Critical Evaluation," *Issues & Studies*, vol. 11, no. 3, Taipei, March, 1975, and Hung Yu-ch'iao, "An Appraisal of the Changing Fuel Structure on the China Mainland," *Issues & Studies*, vol. 10, no. 11, November, 1974.

¹⁴ Vaclav Smil, "Energy in the PRC," *Current Scene*, vol. 13, no. 2, Hong Kong, February, 1975.

¹⁵ These are figures advanced by Alexander Eckstein in *The China Quarterly*, no. 54, April–June, 1973, Table 6, p. 232, and R. M. Field, *People's Republic of China: An Economic Assessment*, Table 1, p. 63. Both sources are cited by Vaclav Smil in *Current Scene*, *op. cit.*

The Cultural Revolution did not end until 1969. A new program with defense preparation as its primary objective was then initiated. This necessitated a sharply stepped-up volume of imports, and consequently, equally larger export earnings to pay for them. By 1970, crude oil production had reached the 20-million-ton level, nearly double that of 1967. One probably should attribute the increase during 1967–1970 largely to Taching and Shengli, and only to a small extent to Takang. Between 1970 and 1973, crude production in China again rose by 150 percent, from 20 million to 50 million tons, if we are to believe Chou En-lai's figures.¹³ Some of this latest large increase probably came from Takang. The point to remember is the substantial lead time required before any large increase in production can be derived from new oil fields after their discovery and the initial flow of oil. The growth of crude oil export to Japan beginning in 1973 came after overall production reached the reported 50-million-ton figure. During the few years that followed the official end of the Cultural Revolution in 1969, China also stockpiled oil as a part of her defense program. Thus, in evaluating China's exportable oil surplus in 1973, allowance should be made for this previous effort to increase inventory. Hence, the total volume of oil available for export by the end of 1973 might be close to the 4-million- to 5-million-ton level reached by actual export in 1974, and was probably somewhat lower.¹⁴

Obviously, as the Chinese economy expands further, its consumption of energy products, including oil, will also increase. In order to estimate the potential exportable surplus, we need to have some notion of the rate at which domestic demand for oil will increase.

First, between 1960 and 1970, Western estimates of the Chinese gross national product (GNP) and industrial production indicate growth rates of 40.2 percent and 31.7 percent, respectively.¹⁵ For the same period, Vaclav Smil estimates the energy production index to have risen from 403 (1952 = 100) in 1960 to 539 in 1970. This is an increase of about 33.7 percent. There is no particular reason why these different series of estimates must be fully consistent with one another, because of the different sources and incomplete, rough data used. However, as an approximate benchmark for reference purposes,

(Continued on page 53)

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“... the uneven distribution of mineral resources . . . plus the essential nature of many minerals mean that the producing and consuming countries are inextricably tied together in the world economy.”

Mineral Resources in the New International Order

By JOHN HELLIWELL

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IN ITS SPECIAL ASSEMBLY of 1974 on the problems of raw materials and development, the United Nations passed a declaration on “The Establishment of a New International Economic Order.”¹ A new world order is certainly coming to pass, probably less by United Nations decree than by the often uncoordinated actions of individuals, groups and nations responding to the complicated political, social, and economic pressures of the mid-1970's. In this and the preceding issue of *Current History*, the spotlight is focused on food and energy resources, whose shortages and price gyrations are at the center of much of the current turmoil. Still other problems involve the development of the world's scarce nonfuel mineral resources.

Mineral resources share with most raw materials a variability of price. For example, the *Economist's* index of metal prices, with a base of 1970 = 100, reached a value of less than 75 at the end of 1971, and then increased to a peak of about 280 at the end of March, 1974. Since then, the index has dropped precipitously, falling below 130 by March, 1975.

Variations of this index are much greater than variations in average metal prices, since many sales are covered by long-term contracts whose prices do not vary with day-to-day quotations on the London Exchange. Nevertheless, even the average prices of most metals and other mineral resources change more dramatically than prices of industrial products. The continuing decline in the metals index probably in-

dicates a widespread expectation of further declines in industrial growth and hence in the demand for metals. The swings of the prices of exports of mineral resources are larger than those of manufactured exports, even when comparisons are made on a decade-to-decade basis.²

The variability in materials prices has a variety of causes. For agricultural products, where planting cycles and crop conditions interact, the factors causing price movement are different from the factors that affect minerals and other extractive resources. The volatility of mineral prices is based partly on the uneven pattern of discoveries, partly on the uneven global distribution of resources, and partly on the key role that mineral resources play as raw materials in the industrial process.

The demand for mineral resources varies with industrial production, while prices move according to more specific factors as well. For example, the uneven progress of technology means that minerals that are in high demand one decade may be in surplus the next. Another complication is created by the fact that many minerals are found in combination with one another. Thus, sulphur found with natural gas may be almost freely available for many years. However, when the demand for sulphur exceeds the available quantities of by-product sulphur, a big shift in sulphur prices may be expected. The final factor that could, in theory, increase or decrease price volatility is the storability of most mineral resources. Most metals and many other mineral resources can be stockpiled in expectation of improved market conditions. If speculators act in a stabilizing manner, then price volatility will be reduced. The reverse can obviously happen also.

The main consequences of volatility in the demand and price of mineral resources are very considerable swings in the revenues of the industries and countries producing particular minerals. This is a problem that producers of mineral resources share with the producers of almost all basic materials.

¹ The declaration was adopted by the General Assembly on May 1, 1974, and published on May 9 as A/RES/3201 (S-VI).

² A comparison of the relative movements of the prices of minerals and other types of exports may be found in the Annex to “Evolution of Basic Commodity Prices since 1950,” prepared by the United Nations Secretary General for the sixth special session of the United Nations (published April 2, 1974, A/9544). The main movements are also shown in Table 1 of “Extractive Resources in the World Economy,” *International Journal* (Autumn, 1974), pp. 591-609, a paper of mine on which the first part of this article is based.

NONRENEWABLE RESOURCES

How important is it that mineral resources cannot be grown like grain or timber? This depends on how easy it is to recycle the mineral resources and also on how easy it is to find and develop substitutes for particular minerals. Some minerals, like lead in batteries and copper in wire, can be easily and inexpensively recycled. Others, like lead and mercury in the environment, are difficult to recover and are dangerous in their unrecovered form. Combustion products of coal, oil and natural gas typically contain little that is recoverable, and certainly nothing that compares with the energy content of the original product.

Economists use the concept of "user cost" to help measure the consequences of the non-renewability of a resource. The "user cost" of a particular resource is the amount that we ought to charge ourselves, when determining output, to take account of the fact that the resource will not be available in the future. An example may help to explain the concept. Suppose that we have copper costing 20 cents per pound to extract, refine, and transport (in terms of 1974 US\$), and that there is enough of that copper to last ten years. Copper is expected to be available thereafter, in unlimited amounts, at a cost of 45 cents per pound, and is then expected to sell at that price for the foreseeable future. In this example, the user cost of a pound of copper today is equal to 25 cents (i.e., 45 cents - 20 cents) discounted back ten years. Thus, when we are using copper, we should be treating it not as a 20-cent resource, nor as a 45-cent resource, but as a resource worth slightly less than 45 cents because it is possible to defer until some future period the need to spend 45 cents to develop a pound of copper or its substitute. The appropriate value for copper is thus equal to the direct costs of extraction plus the user cost. The notion of user cost is closely related to the concept of an "economic rent."³

Another feature of mineral resources is their uneven distribution across the globe, as well as their preponderance among the exports of the less developed economies. This uneven distribution is obvious from both geological and economic analyses, but it is difficult to quantify. The United Nations has recently attempted to establish uniform estimates of the size

and location of world mineral reserves. The problems of establishing uniform international definitions are compounded by the fact that most estimates of mineral reserves are based on exploration effort and on the anticipated future relationship between mineral prices and resource extraction costs, which in turn are highly dependent on expected future changes in the technologies governing the extraction, use, and recycling of mineral resources.⁴

However difficult it is to measure, the uneven distribution of mineral resources means that they are very important in international trade—the uneven distribution plus the essential nature of many minerals mean that the producing and consuming countries are inextricably tied together in the world economy. For example, in 1970, the developing countries produced 33 percent and consumed 6 percent of the world's production of nine major nonfuel minerals.⁵ But the fact that producers and consumers are tightly linked does not predict who shall reap the main benefits from mineral resources. The distribution of the economic rents from these resources is one of the most important and volatile issues in the world economy at the present time.

ECONOMIC RENTS

Economic rents exist in the mineral industries because their resources are nonrenewable, and because the available deposits differ in accessibility and cost of development. The concept of user cost provides the clue to the nature of an economic rent. The efficiency price for a resource is equal to its direct costs of development plus an amount indicating the present value of the higher future costs of developing substitute resources when they are expected to be required. An economic rent exists whenever the value of a mineral exceeds the total costs of its development, including all labor costs and a full return on the required capital, but not including user cost.

To whom do the economic rents from mineral resources belong? If the whole world economy operated on a competitive basis, economic theory tells us that economic rents should be equal to user costs and should fall into the hands of the primary resource owners. Indeed, if the price of a resource were not high enough to cover user cost, the individual mine owner would not produce. On the other hand, if economic rents became greater than user costs, then new mines would be brought into production until the price of the resource was driven down to restore the equality.

The essential problem for resource owners lies in establishing some system to collect the economic rents derived from natural resources equitably, and to ensure adequate competition among potential purchasers. Purchasers would like to see competition more active among the sellers than among the buyers;

³ The concept of user cost is usually employed in a less aggregate context, where it can be more precisely defined. See A. D. Scott, "The Theory of the Mine Under Certainty," in Mason Gaffney, editor, *Mineral Resources and Taxation* (Madison, 1967).

⁴ United Nations, Progress Report of the Secretary-General on "Medium-Term and Long-Term Projections of Reserves, Supply, and Demand of Energy, Minerals, and Water Resources" (E/C.7/52 and E/C.7/52/Add.1, March, 1975).

⁵ World Bank sector program paper, *The Non-Fuel Mineral Industry* (Washington, 1973), quoted on page 4 of the February, 1975, Report of the (UN) Secretary-General on "The World Mineral Situation" (E/C.7/51).

then the buyers could purchase the resources at a price low enough to ensure that some of the economic rents would fall into their hands. From the point of view of reasonable efficiency in the world economy, there ought to be enough competition among the sellers of natural resources to ensure that the lowest cost sources were exploited first, with higher cost sources only brought into play after lower cost resources were fully utilized.⁶

MULTINATIONAL FIRMS

Perhaps the key issue raised by the multinational firm lies in its control of many links in the resource development chain. The relative scarcity and large size of the firms and their direct and indirect influence on the governments of the host countries throw a heavy shadow on the competitive assumption that the full economic rent from natural resources accrues to the resource-owning jurisdiction in the form of taxes or bids for mineral rights. Even more important, possibly, is the technical sophistication of the multinational firms compared to enterprises and governments in the host countries.

The role of the multinationals in resource development has been interpreted in a number of ways. At one extreme, they are regarded as the primary hope

for the use of rational economic criteria in resource development and as the means of greatly lowering costs because of their ability to develop and move technical equipment and skilled labor.⁷ At the other extreme, the multinationals are considered uncontrollable grabbers of resources, who use their great power to subvert governments and societies to further their own interests. A variant of this view is that the multinationals act as agents of their home countries. Sometimes, as with ITT in Chile, it seems difficult to tell which way the strings pull. The facts are not so simple as either of these extreme views.⁸

By the early 1970's, in the "new world order," most multinational firms were likely to embark on new resource developments "only on the basis of a partnership with local private interests and/or the governments of the countries concerned."⁹ Nevertheless, many producing countries believed that they would inevitably bargain at a disadvantage with multinational firms unless producer groups were formed to right the balance.

JOINT ACTION BY PRODUCING COUNTRIES

The Organization of Petroleum Exporting Countries (OPEC) is obviously the most important producer group in the world today. But in the shadow of OPEC, a number of groups of mineral exporters are meeting to see whether they can jointly obtain better terms of trade for their resource exports. The objectives of such groups are varied, ranging from the reduction in the volatility of prices to the establishment of a countervailing force to obtain greater revenues from resource development.

The formation of producer groups was encouraged by the United Nations declaration on "the establishment of a new international economic order," and subsequent reports by the United Nations are the best source of information about what has happened.¹⁰ As reported in these United Nations documents, the main recent developments are as follows.

The International Bauxite Association (IBA) was formed in March, 1974, and includes 10 countries, which produced 80 percent of the world's bauxite in 1973. In terms of production, Australia, Jamaica, and Surinam are the three most important members, producing 27.8 percent, 21.3 percent, and 10.6 percent respectively of the 1973 bauxite production.¹¹ The association has agreed in principle to a common pricing policy, with its exact formulation to follow the completion of a study on pricing and taxation policy. In the meantime, the major producing countries have acted independently to raise revenues and, in some cases, to reacquire the ownership of their bauxite deposits. For example, Jamaica has instituted a national bauxite levy to equal, in 1975-1976, 8 percent of the realized price of primary aluminium; this is expected to increase Jamaica's

⁶ The non-renewability of mineral resources complicates this principle somewhat. If we use all the lowest cost reserves in the present generation, and either consume the benefits or pass on more roads and buildings to future generations, the recipients may not be grateful. Sharing the benefits of nature with later generations may require restricting our own use of scarce low-cost deposits. Offsetting this requirement somewhat is the possibility that future technology will reduce the relative value of today's low-cost deposits.

⁷ This argument is made by Peter Drucker in "Multinationals and Developing Countries: Myths and Realities," *Foreign Affairs* (October, 1974) pp. 121-134.

⁸ An exhaustive survey of studies relating to the role of multinational enterprises in foreign investment has been compiled by G. C. Huffbauer, "The Multinational Corporation and Direct Investment," in P. B. Kenen, ed., *International Trade and Finance: Frontiers for Research* (New York, Cambridge University Press, 1975). For a recent analysis of the political role of multinationals, see J. S. Nye, "Multinational Corporations in World Politics," *Foreign Affairs* (October, 1974), pp. 121-134.

⁹ United Nations Industrial Development Organization, *Non-Ferrous Metals: A Survey of their Production and Potential in the Developing Countries* (New York, 1972), p. 11.

¹⁰ The Secretary General's September 30, 1974, report on the "Permanent Sovereignty Over Natural Resources" (A/9716) describes in some detail the post-1970 changes in ownership patterns and pricing in petroleum and bauxite, and in less detail events relating to copper and mercury. An annex to the paper categorizes 875 post-1960 cases of nationalization of foreign enterprises. The Secretary General's subsequent report under the same title (January 31, 1975, E/C.7/53) describes more recent changes relating to petroleum, bauxite, copper, and iron ore.

¹¹ This and other information on the aluminum industry is reported in "The Structure of the International Aluminum Industry," an annex to *The World Mineral Situation*, UN document E/C.7/51, February, 1975.

bauxite revenue about sixfold, from \$25 million to at least \$160 million per year.

The Intergovernmental Council of Copper-exporting Countries (CIPEC, initially comprising Chile, Peru, Zaire, and Zambia) was formed in 1967. Individual countries nationalized their control over their copper resources, but until recently they did not co-ordinate production and prices. Effective in December, 1974, CIPEC announced a quota system involving a 10 percent reduction in all copper shipments. In addition, consideration is being given to building a buffer stock under the International Monetary Fund's stock-financing facility, and there has been discussion of collaboration among OPEC, IBA, CIPEC, and other producer groups.

The Fourth International Tin Agreement, which took effect in 1971, is a longer-standing arrangement among producers and consumers; it has included the only buffer stock financed under the International Monetary Fund's stock-financing facility. However, the agreement was suspended when the price of tin rose to very high levels in early 1974.

Thirteen countries that produce 70 percent of the world's iron ore have been negotiating with the aim of establishing an Organization of Iron Exporting Countries (OIEC), possibly by mid-1975. Countries controlling 83 percent of the total market-economy mercury production also formed a producers' association in May, 1974, and raised mercury prices at that time by 25 percent.

If a producers' association is to be viable over the longer term, there must be a substantial community of interests among the members, perhaps some external threat (such as that sometimes posed by the bargaining strength of the multinational firms), and a continuing world requirement for the product. Analysts who differ in their forecasts of the success of such groups usually differ in their estimates of the members' willingness to share the costs and benefits among themselves, and in their estimates of the ability of the consumers drastically to cut their use of the product if its price were pushed very high.¹²

The United Nations has been involved in several

¹² For a view that producer groups will be increasingly prevalent, see C. F. Bergsten, "The New Era in World Commodity Markets," *Challenge* (September/October, 1974), pp. 34-42. For the opinion that these efforts will be unsuccessful, see R. F. Mikesell, "More Third World Cartels Ahead?" *Challenge* (November/December, 1974), pp. 24-31.

¹³ United Nations, *The Impact of Multinational Corporations on Development and International Relations* (E/5500/Rev 1, ST/ESA/6, 1974). The main background study used in the preparation of this report was another UN document, *Multinational Corporations in World Development* (ST/ECA/190, 1973).

¹⁴ *The Impact of Multinational Corporations*.

¹⁵ The programme of action, adopted May 1, was published on May 16 as UN Doc. A/RES/3202 (S-VI).

¹⁶ *Op. cit.*, p. 11.

ways in the design of international policies relating to resource development. For example, the most influential study of the role of multinational corporations was made by a "Group of Eminent Persons" established by the United Nations in 1972 and reporting in the middle of 1974.¹³ The study covered all types of multinational corporations, with primary emphasis on problems that arise in the manufacturing and resource-based sectors. The key recommendation, which was endorsed by the Secretary-General, was that the Economic and Social Council of the United Nations should take action to "harmonize relevant national policies and provide a framework within which the global strategies of multinational corporations should operate."¹⁴ The chief mechanism for collecting information and proposing new policies was to be a Commission on Multinational Corporations, to be established under the Economic and Social Council, with an information and research center on multinational corporations under its control.

The 1974 U.N. declaration on the establishment of a new international economic order paid special attention to multinational corporations, and offered encouragement to the formation of producer groups. However, there was little in the way of description of the national or international policies that would help to give the right shape to the new economic order. The subsequent "program of action on the establishment of a new international economic order" was somewhat more specific and helpful, including suggestions for the reduction of tariff barriers that affect developing countries and attempts to stabilize the terms of trade of the resource-producing countries by formulating commodity agreements where necessary in order to regulate and stabilize world markets for raw materials and primary commodities.¹⁵

The section on the regulation and control of the activities of transnational corporations suggested an international code of conduct for transnational corporations, designed to prevent interference in the internal affairs of host countries, to eliminate restrictive business practices, to bring about the transfer of technology and management skills, and to regulate the repatriation or re-investment of profits accruing.¹⁶ The legal status of such a code of conduct was not explored within the program. The United Nations declaration encouraging the efforts of groups of resource-exporting countries to control their natural resources for the benefit of their economic development is more likely to result in action. ■

John Helliwell is the author of "Extractive Resources in the World Economy," *International Journal*, Autumn, 1974, and a contributor to *The Mackenzie Valley Pipeline: Arctic Gas and Canadian Energy Policy*, edited by J. H. Pearce (Buffalo, N.Y.: McClelland and Stewart, 1974).

"A number of alternative resources, some of which are available in almost unlimited amounts, could be used for energy when the nonrenewable resources are no longer adequate. . . . Unfortunately, resources that could be brought into commercial use rapidly apparently will not be able to satisfy all man's energy demands when the production of nonrenewable fuels begins to decline."

Developing Alternative Energy Sources

BY HARRY PERRY

Consultant, Resources for the Future

IN THIS CENTURY, the industrialized nations of the world have relied largely on nonrenewable fossil fuel resources to supply their energy needs. Coal was the predominant fuel form in the early 1900's; during the past 25 years it has been displaced by oil and, to a lesser extent, by gas. Coal now supplies 32.7 percent of the world's energy needs, gas, 19.2 percent and oil, 44.2 percent. All other energy sources combined contribute only 3.9 percent. The use of nuclear energy to generate electricity is expected to grow rapidly in the last quarter of this century, but its contribution to the world's energy supply remains small. The contribution of renewable energy resources like wind and water power to energy supplies has declined in importance, although water power still plays an important, if diminishing, role in supplying energy in most technologically advanced countries. In the United States, hydroelectric power now supplies less than 4 percent of the total energy demand and about 16 percent of the electricity that is produced. In Sweden, on the other hand, hydropower generates nearly 75 percent of all the electricity produced.

The energy supply situation is markedly different in the developing countries. Not only is total energy consumption per capita low compared to industrialized countries, but a significant percentage of the energy is supplied by noncommercial fuels like wood, dung, vegetable and other wastes. In Pakistan, it is estimated that 33 percent of the energy consumed is supplied by noncommercial fuels while in India the percentage may be as high as 50 percent.

During the period in which energy statistics have been collected, the figures indicate that energy use has been growing at an exponential rate, the exact use varying from country to country. While energy growth rates may decline somewhat if energy prices continue to remain high, there is little or no expectation that the rates will become negative. Even if world per capita consumption remained at 1973 levels, energy use would still increase as a result of the growth

in world population that cannot be reversed, at least for a number of decades. Moreover, the developing countries have legitimate aspirations to improve economic and social conditions for the less affluent segments of their populace; realistically, this can only be accomplished by a greater average per capita energy consumption.

Given these prospects for an expanding energy demand, the adequacy of future energy supplies becomes an important issue. Are there sufficient world supplies of nonrenewable resources to satisfy projected demands, or will new energy resources have to be developed? It is not possible to answer this question with any degree of certainty; the amount of ultimately recoverable nonrenewable resources depends on a number of factors, none of which can be determined in advance with any precision. There are at least three important variables involved. They are: first, the amount of the resource yet to be discovered and its quality and geologic setting; second, the nature and type of improved technology that will permit resources not now recoverable to be extracted and used; and third, the price levels at which the resources can be marketed. The most widely quoted estimates of the ultimately recoverable nonrenewable resources project that extraction of the world resources of oil, gas, and uranium (using light water reactor technology) will be on the decline sometime in the years between 2000 and 2025. Coal, on the other hand, should be available until far into the twenty-first or even into the twenty-second century. Methods will have to be found to control its adverse environmental effects.

Of the energy resources now used in commercial quantities, only hydroelectricity, fuel wood, and solar heating and evaporation are renewable. Oil, coal, gas and uranium will eventually be depleted. However, unlike the fossil fuels, reserves of uranium can be greatly extended, by as much as 50 to 75 times, if breeder reactor technology is developed.

Hydroelectric resources have been developed to dif-

ferent degrees in different countries. Although some nations have developed a large share of their usable hydroelectric sites, other countries have been unable to develop their hydroresources because of the remoteness of suitable sites, the large amount of capital required to build dams and the lack of an electrical transmission grid that would use the electricity generated.

Additional hydroelectric generating facilities will be installed in the future, particularly in less developed countries with large undeveloped hydroelectric sites. But the rate at which this occurs will be dependent on capital availability and the speed with which demand for electricity grows. It is unlikely that hydroelectricity will be a major energy source in the future, although it may be of local importance in some countries.

ALTERNATIVE ENERGY RESOURCES

If this assessment of the availability of usable energy resources is accurate, research on the development of new energy resources should be initiated. If the United States experience with developing nuclear generating technology is taken as a guide, nearly 50 years of research, development and application will be required before a new fuel form will supply as much as 25 percent of energy demand. The estimates of when world energy supplies of nonrenewable resources will start to decline assume that there will be a flow of energy from the resource rich to the resource poor nations under normal conditions of world trade. However, since October, 1973, when the Organization of Petroleum Exporting Countries (OPEC) cartel started to function well, this condition has not been met in world oil trade—the most important of the currently used energy resources. In addition, some nations are already energy-resource deficient; for economic, security and balance-of-trade reasons, they prefer to use other available and developable indigenous resources.

The alternative energy resources that are now under intensive study are 1. the nuclear breeder reactor, which would extend the uranium resource base; 2. fusion; 3. bituminous sands and oil shale; 4. solar energy, including wind; 5. geothermal energy; and 6. tidal energy.

THE BREEDER REACTOR

The nuclear-fueled light water reactors that are currently operating utilize about 1 percent of uranium. Breeder reactors, on the other hand, may be able to utilize from 50 to 75 percent of the uranium. This is done by converting the nonfissionable U_{238} (which makes up over 99 percent of the uranium found in nature) into plutonium, which can be used as a nuclear fuel. Some plutonium is formed in light water reactors, is exposed to the neutrons released by the fissionable U_{235} . However, since most of the neu-

trons in a light water reactor are needed to keep the reactor operating, the amount of plutonium produced is small.

By redesigning the reactor core, it is possible to accelerate the production of neutrons that make plutonium. This "fast" reaction can be accomplished by packing the nuclear core more densely and using a more enriched fuel. The excess neutrons that are created would normally escape from the core and be lost. In the breeder reactor, the core is surrounded by a blanket of nonfissionable U_{238} that absorbs the neutrons and produces fissionable plutonium.

Like light water reactors, fast breeder reactors can be cooled to remove the heat produced in the core in a number of ways. The heat removed is used to generate electricity. In the early stages of the Atomic Energy Commission (AEC) breeder reactor program, a variety of cooling methods were investigated on a small scale (molten salt reactors, gas cooled reactors, liquid metal reactors), but nearly all of the current effort is on the liquid metal fast breeder reactor (LMFBR). In the LMFBR the heat is removed by sodium, which is a liquid at operational temperatures. As a coolant, liquid sodium has a number of favorable properties; but since it reacts violently with water and burns on contact with air, it will require specialized safety equipment. In addition, entirely new designs of pumps, valves, and so on must be developed to use liquid sodium.

Similar LMFBR programs are being carried out in France, the United Kingdom, the U.S.S.R., and West Germany. The French reactor has been in operation and connected to the commercial electricity grid for about one year.

In 1972, the Atomic Energy Commission entered into an agreement with Tennessee Valley Authority (TVA) and Commonwealth Edison Company of Chicago to construct a breeder demonstration plant on the Clinch River near Oak Ridge, Tennessee. Originally, it was estimated that the breeder would cost \$500 million and that industry would contribute about one-half or \$250 million. The most recent estimates of costs for the demonstration plant are between \$1.5 and \$2.0 billion, reducing industry's share to about 15 percent of the total. Cost of the entire LMFBR program, including development work that is necessary as a precursor to the construction of the demonstration plant, is now estimated at \$5 billion.

The lengthy delays in the program, the large cost overruns, technological problems, environmental objections and the long lead times before the LMFBR will be commercially available have raised serious questions about the high priority that has been assigned to the LMFBR in the federal energy research and development budget. In addition to these problems, there is strong opposition to the LMFBR pro-

gram from environmental and other groups. Their objections are related to the technological soundness and inherent safety of these reactors, the questionable economics of generating electricity from the LMFBR compared to other alternatives, the absence of a "need" for the LMFBR to extend our uranium until more exploration for uranium has been conducted to define the extent of uranium resources, and the threats posed by nuclear terrorism, transportation accidents and acts of God.

The handling of large volumes of plutonium at various stages of the fuel cycle is of particular concern; exposure to minute quantities of plutonium appears to produce cancer in test animals.

But despite the many objections to the development of the breeder reactor in the United States, no major changes have been made in the breeder program plans, except to accommodate delays and budget overruns. As now contemplated, the program should "lead to the establishment of a variable commercial breeder reactor option for electricity generation in the early 1990's."¹ Successful development of the breeder, including satisfactory answers to all the questions raised by environmental groups, would extend uranium resources beyond normal national planning periods.

Because of the unexpected delays in the program so far, it is likely that the early 1990's as the target date may be optimistic. Moreover, sufficient doubts have been raised by opponents of the breeder as to its economic viability (even if it is technically viable) that its commercial application may be further delayed. In any event, the breeder will be deployed only if it is competitive with the marginal cost of generating additional electricity by other means.

CONTROLLED THERMONUCLEAR REACTIONS

Fusion energy is the basic energy of the sun and stars. Experimental work on a controlled thermonuclear reaction is now in its third decade. The motivation for this research is that, if it can be brought to a successful conclusion, it will provide the ultimate solution to the world's energy requirements. Either two deuterium atoms or a deuterium and tritium atom (both are isotopes of hydrogen) can be used as the fuel for the fusion reactor. Deuterium is found in nature in almost unlimited quantities and can be extracted from sea water at very low cost. The deuterium-tritium reaction, however, will probably be used first as a fuel for fusion reactors; since its "ignition temperature" is lower than that of other fusion reactions, it is the least demanding in terms of the physical conditions that must be met to achieve a controlled thermonuclear reaction. Tritium, however,

exists only in trace quantities in nature and must be bred by reacting a neutron with lithium.

The energy represented by the use of 30 pounds per hour of fusible material is equivalent to the energy needed by all of the United States electric generating capacity (450,000 megawatts). The corresponding amount of coal required would be 280,000 tons per hour. As a result, it is expected that both the initial cost of the fuel and the environmental impact of fuel production will be miniscule.

Thus far, a fusion reaction has been reproduced in the form of a hydrogen bomb, but a controlled reaction has not yet been attained. To prove the "feasibility" of the reaction, the two nuclei of the fuel will have to be shown to have sufficient energy to come together and fuse. To do this, the particles will have to overcome their high electrical charges that keep them apart. Temperatures of 10 to 10 million degrees centigrade must be sustained for about 1 second at the same time that a threshold density of the plasma is maintained.

Two different methods demonstrate the fusion reaction. One uses a magnetic field to keep the plasma confined and away from the vessel walls. The more recent approach to controlled fusion—laser fusion—uses a high power laser beam to irradiate a pellet made of fusion fuel. A laser much larger than any that has yet been constructed will be needed to supply the amount of energy required. The research is still in its early stages and there is considerable optimism about its probable success. However, it is still too early to predict the probable success of this approach.

The advantages of fusion energy are the abundance of fuels to produce it, a much smaller environment impact than fission technology, no danger of a runaway reaction, and the longer term probability that laser technology can be developed to generate electricity directly.

Conceptual designs of large-scale plants have already been made by several fusion research scientists and engineers. In addition, studies have been made of the amount and type of radioactive waste materials that must be disposed of when a plant is dismantled. (The refractory metal structural material of the reactor will become radioactive as a result of exposure to the neutrons produced by fusion reaction.) Until research has progressed further, it is impossible to estimate the costs of electricity generated from fusion reactors. The costs of research and development to build and operate a demonstration fusion reactor were estimated in 1971 to be about \$2.5 billion. It will probably require at least twice this amount before a demonstration reactor is completed.

BITUMINOUS SANDS AND OIL SHALE

Major deposits of tar sands are found in nine countries, but by far the largest deposits are located

¹ From the Summary Sheet, "Proposed Final Environmental Statement—Liquid Fast Breeder Reactor Program," U.S. Atomic Energy Commission, February 11, 1975.

in Canada, where reserves are currently providing oil tar sands commercially in one large extraction plant. Nominal production has also been reported in Albania, the U.S.S.R., Romania and Trinidad. Although tar sand deposits (other than those found in Canada) are not large when compared to petroleum reserves and resources, the tar sands will unquestionably be used extensively when the easily exploitable petroleum deposits have been exhausted.

The Canadian tar sands are mined by conventional strip mining methods, but in-situ recovery methods should be possible. Underground mining of tar sands might be very difficult.

The mixture of sand and tar is transported to an extraction plant where it is treated with hot water and steam in a slurring vessel to separate the bituminous material and sand. The sand is discarded from the water-oil mixture and the water and oil are then separated. The oil that is recovered is then refined by methods similar to those used for petroleum. There are no unsolved technical problems, and the commercial production of oil from tar sands will begin when the economics are favorable.

Oil shale deposits (found in every inhabited continent) are much more extensive than tar sands, and their quality varies over a wide range. High grade (25 to 100 gallons per ton or more of shale) identified resources alone are estimated to contain 720 billion barrels of oil. Total oil shale resources of this quality may contain as much as 17,000 billion barrels of oil, or 25 times the current estimates of the ultimately recoverable petroleum resources of the world. In deposits of lower quality shale (10 to 25 gallons per ton of shale), the amount of oil is estimated to be nearly 20 times the amount of the higher quality reserves, or 325,000 billion barrels.

Oil shale resources can be exploited by either surface or underground mining, using methods similar to those used in mining coal. A number of different in-situ methods have been and are being tested, but this technology is not so advanced as conventional mining methods. When conventional mining methods are used, the oil shale is crushed to the desired size and heated to drive the oil from the rock. The recovered oil is then refined by methods similar to refining petroleum. In in-situ processes, the oil in the oil shale is brought to the surface in combustion gases that flow through the formation and is recovered from them.

Commercially, oil shale has been used longer and more widely than tar sands to produce oil. Commercial production started in the middle of the 1800's and oil was produced in small amounts in a number of countries. Recently, Brazil started a new oil shale plant. A number of new processes for retorting the shale have been demonstrated in the past 25 years, and no unresolved technological problems block the

establishment of an oil shale industry. However, some environmental problems still remain.

The major environmental problem for both oil shale and tar sands (except for in-situ processing) is the disposal of the waste from which the oil is separated. Approximately three-quarters of the material processed must be discarded. Moreover, in the case of oil shale, the volume of waste is somewhat larger than the original volume of the oil shale. Measures must be taken to prevent the waste piles from leaching into streams, damaging plant and animal life. There is interest in in-situ production of oil shale because it has fewer environmental problems and requires smaller amounts of water—a resource in short supply in Colorado, which has the highest grade oil shale deposits in the United States.

Once environmental problems are resolved (and this should be possible at a price) commercial production of oil shale will be initiated when economics are more favorable.

SOLAR ENERGY

Because of the current shortage of clean domestic fuel supplies, interest in utilizing solar energy has grown rapidly in the United States and Japan in the past several years. Solar energy is dilute; large collecting surfaces are necessary to gather reasonable quantities of heat. Moreover, the supply varies widely over time and under various weather conditions. As a result, energy collected when the sun is shining must be stored for use when it is not.

A number of methods for using solar energy have been proposed, from growing various crops for their fuel value to converting the sun's energy directly into electricity on a space platform that is in synchronous orbit with the earth. The methods for using solar energy include: space heating and cooling and hot water heating; wind energy; conversion to electricity by direct conversion through the use of solar cells (terrestrial and space) or heat engines utilizing thermal collectors or ocean temperature differences; production of clean fuels, growing organics and bioconversion to hydrogen or methane.

Most of these methods of harnessing solar energy have been used under special circumstances and usually on a small scale. The technological problems have been solved but the process must be made more economical by developing lower cost methods of collecting, storing and utilizing the resource.

The technology for solar heating has been developed and demonstration homes have been heated using solar energy. The state of technology for solar cooling is not so far advanced, but research indicates that solar cooling should be available for use in the near future. The chief obstacle for both solar heating and cooling is the large capital investment required for the system, especially the solar collector plates. Because

of the initial cost, residential building contractors, who build largely on a speculative basis, are hesitant to install expensive solar heating systems, even though there would be fuel savings over the life of the home; home buyers are sensitive to initial costs.

The development of commercial solar heating systems is handicapped by a lack of building design criteria, of knowledge of production economics and of public familiarity with solar heating and architectural problems. As a result, federal programs have been undertaken to improve the existing systems and to demonstrate solar space conditioning technology. Incentives like tax write-offs, the federal use of solar space conditioning to encourage large-scale commercial production of solar systems, and modification of building codes should help accelerate commercial development.

Heating of hot water by solar energy has been used on a commercial scale in Florida, Israel and tropical countries. As for solar heating, greatly increased use of solar hot water heating is dependent on more favorable economics and on reducing the institutional barriers that prevent or deter its application.

Wind energy has been used for many years for pumping water and for generating small amounts of electricity, usually at isolated locations. Wind energy has some of the same drawbacks as solar energy—the energy form is very dilute and highly variable, requiring storage for use during periods when the wind is not blowing. As with solar energy, there are no technologic problems with respect to its use in small-scale applications, but the economics are not yet generally favorable. Moreover, wind speeds must reach a minimum before wind energy can be considered for use. The utilization of wind power is site specific. Nonetheless, with the rapid increase in fossil fuel prices, there has been a renewed interest in wind energy and studies are under way to determine whether wind energy is competitive in some locations.

Utilization of solar energy in heat engines (using either collectors or ocean temperature differences), direct conversion to electricity in solar cells and producing clean fuels by growing organics by bioconversion will require extensive research and development before any of these processes can be used on a large scale. The basic difficulties in using solar energy for heat engines is that the heat must not only be collected but it must also be concentrated to reach sufficient temperature levels. A collecting surface of 10 square miles would be required to provide heat for a 1,000-megawatt power plant even in solar rich regions and the long distances between the generating plant and the collectors create technical problems and increase costs. Before solar thermal engines become commercial, improved collecting surfaces with long life, suitable heat transfer materials and better methods of energy storage are needed.

The utilization of the temperature differences of the sea to generate electricity raises difficult design problems for the large and long intake tube necessary to reach the cold water at the lower sea levels needed to cool the condenser. Because the temperature difference is small, large generating equipment will be needed per installed kilowatt, and this will lead inevitably to capital investments that may be too large to balance the savings in fuel costs.

Direct conversion from solar energy to direct current electricity, using photovoltaic devices made of silicon, has been used extensively in the space program and has proved to be dependable and long lasting. As with other solar sources, a low-cost method of energy storage needs to be developed for most commercial uses. Unfortunately, the cost of silicon photovoltaic devices is very high. Also, since direct current electricity is produced, it would have to be converted to alternating current before it could be used in most existing electrical devices.

The costs of silicon photovoltaic devices will have to be reduced by a factor of 10 to 100, and efficiencies will have to be increased from their current level of 10 to 15 percent if solar photovoltaic systems are to be competitive with electricity generated by conventional means.

Solar energy could also be used to provide new clean energy resources if fast-growing crops on the land or in the water could be developed, because such crops could be harvested, dried and burned directly as fuel. In addition, a variety of biological conversion processes could produce fuels indirectly from solar energy. Wood and grains can be fermented to methanol, which can be used directly as a fuel. Algae can be used to produce methane by bacterial action. Fuels can also be produced indirectly from solar energy by processing and upgrading mineral wastes. All these uses of solar energy have low conversion efficiencies and none are now competitive with conventional fuels. Either improved technology will have to be devised to reduce the costs of solar energy from these sources, or the price of conventional fuel will have to rise further to make these forms of solar energy competitive in the marketplace.

If energy prices maintain the high levels of 1974,
(Continued on page 52)

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"One can imagine a global resource organization playing an important role in future resource development, but it might be a somewhat less monolithic endeavor than is implied by the word 'control.'"

International Controls of Scarce Resources?

BY STERLING BRUBAKER

Senior Research Associate, Resources for the Future

AN ORGANIZATION to control the development and allocation of the world's energy and other scarce resources? If they mean what they say, these are powerful words—"control," "development," and "allocation." There are no real precedents for such an organization and its establishment could be an event of tremendous import. Why is a new system of allocation needed? By what principle would a world organization allocate supplies? And why would an international organization be more effective in providing for supply than the present system or certain other alternatives?

Under the present rule of national sovereignty there are no "world" resources—only national resources.* Furthermore, those international organizations that claim to promote global welfare (financial organizations excepted) do not develop, control, or allocate much of anything. They are voluntary organizations and derive their limited authority either from wide consensus on objectives or from simple mutual convenience.

An international organization to control scarce resources would represent a sharp break. Inherent in the concept of allocation is the idea of depriving some in favor of others. Many see unequal access to resources as a cause, not a mere reflection, of income inequality; in effect they would seek income equality by resource rationing. Indeed, if carried to the logical extreme of full equalization of resource use among nations, there would be revolutionary consequences for both rich and poor countries. Would there be worldwide support for this?

Whatever its likelihood, the need for international rationing should not be taken for granted either. It appears to assume a strictly limited supply of resources that must be "equitably" shared. Concern that the world will "run out" of resources is an old concern that has been consistently mistaken. In

practice, the extension of the territorial exploration for minerals and improved means of finding, extracting and processing them have permitted exponential increase in the supply. It is the increase in the rate of use combined with the fact that potential resources are finite that brings the question of supply adequacy again to the fore.

Resources occur in geological patterns that in no way conform to political boundaries. Some major industrial countries, like the Soviet Union and the United States, still produce the major portion of their resource needs internally. But industrialized countries, with their long records of exploration and production, have already used a significant part of their original endowment of high quality resources—less so in lightly populated countries of continental scale like the Soviet Union, Canada and the United States than in the smaller and densely populated areas of Europe and Japan. Moreover, while a particular country may be well endowed with several resources, none is equally provided with all. Consequently, for resources in general, and even more for particular resources, an unequal geographical distribution prevails. But what difference does this make? In the modern world, geographical distribution has not governed access.

How, then, have resources been developed and allocated? Certainly not through any international organization, despite the interdependence that unequal endowments imply. Like any other economic resource, whether capital, labor, or goods, the principal means has been through the operation of markets. For minerals and fuels this has meant international trade and investment in resource commodities. Under a system of unimpeded trading and investment, all have equal access if they can afford to buy, and producers have incentive to expand output. In practice, there are many impediments to international investment, and trading access is far from equal because of income differences and because producers may choose to restrict exports for various reasons.

A special feature of the resource system concerns

* This statement pertains to the geographically fixed resources discussed in this article. Global environmental systems and migratory fish, birds, or animals are international or global resources. At present, efforts are being made to include seabed resources of the deep ocean in an international regime.

the relationship between developed and less developed countries (LDC's). Although industrial countries trade more ores, minerals, and raw materials among themselves than with LDC's, much attention focuses on the large net flow from LDC's. The latter are not major users of resource commodities, yet they may have original resource endowments that are comparatively unutilized. This net flow from LDC's to developed countries is growing rapidly, leaving developed countries increasingly dependent on LDC's, especially for petroleum.

Of course, no country gives up its resources for nothing, and under the doctrine of sovereignty each state has full control of its resources. The essence of trading is that both sides may gain—each gets something it values more than that which it gives up. Moreover, economists have argued long and convincingly that a system of unfettered trade allows each country to specialize in those lines where it enjoys a comparative advantage, thereby improving international efficiency and the incomes of all. Why then seek an organization to allocate resources? Why not continue to rely on the trading system as the best means for their development and allocation?

Dissatisfaction with the present system arises mostly from the LDC's, although increasingly they are joined by the alarmed or conscience-stricken citizens of developed countries. It is argued that the market system results in severe income inequality, which is inequitable and profoundly immoral. Even if we concede that this has been the outcome, it does not follow that this must be attributed in any important degree to inequitable allocation of scarce natural resources under the market system. On the contrary, at least up to the present, it is the abundance of resources that has depressed the income of LDC sellers. In a world of resource constriction, unequal access to resources might become a cause of income inequality and thereby give weight to the moral argument, but to date income inequality has more complex roots and requires a different cure.

INTERNATIONAL TRADE ENCOURAGED

The market system has been the main instrument for developing and allocating resources in the post-World War II years. A great deal of international effort has gone into facilitating trade, including trade in resources. The International Monetary Fund has acted to stabilize currencies, and the General Agreement on Tariffs and Trade has sought to reduce tariffs and other barriers to trade. International lending agencies, like the International Bank for Reconstruction and Development, and regional development banks, United Nations development agencies, and the foreign assistance programs of developed countries have all helped to build the infrastructure required for developing minerals in the

LDC's; they have also invested directly in producing enterprises, in some cases. Investment insurance programs likewise have favored trade in resource commodities.

Commodity agreements that attempt to regulate the production, marketing, or stocks of designated commodities represent one way to improve the terms of trade for resource commodities. While LDC's have participated in these efforts at a government level in recent years, the checkered career of such attempts goes further back and involves commercial interests from developed countries as well. Commodity agreements are often couched in innocuous language about stabilizing markets, and indeed stabilization in itself is a worthy goal for both producers and consumers. But the chief aim of most commodity agreements is to raise the price of the commodity in question. In some markets, less formal or even illegal methods may be employed to the same end.

Where the number of producers is few, entry of new producers difficult, and demand relatively insensitive to price, either oligopolistic price leadership or cartel arrangements may be attempted. The most successful current attempt to "stabilize" prices upward has been made by the oil cartel, where the participants are the governments of exporting countries. The success of the Organization of Petroleum Exporting Countries (OPEC) has not gone unnoticed by other LDC's, who yearn to clamp a similar stranglehold on other natural resources.

Preferential trading arrangements are an effort to gain assured market access in such groupings as the European Economic Community (EEC) or in the markets of industrial powers. At the same time the LDC's have sought to eliminate tariffs or quotas that inhibit their sales in the developed countries. Note that these measures, like commodity agreements and cartels, seek only to improve the sellers' revenues and not to allocate scarce supplies. Likewise, the more arduous terms that LDC's impose on foreign investors in their resource industries are aimed at increasing their share of the net rent from the exploitation of their resources. The LDC's have learned that it is possible to renegotiate investment agreements once the investments are in place; they have used this device to enhance their share of the revenues.

Even taking the most charitable view of cartels, commodity agreements, preferential trading arrangements, and investment controls as modern efforts to rectify unequal power, these devices do not equalize access to natural resources except through their effect on income. For the world's poorest nations, not blessed with resources amenable to such arrangements, the inequality is multiplied because they are priced out of commodity markets.

While the trading system, with its shifting degrees of unequal power, has been the principal means for allocating resources, a few specific international agreements have governed some resources. A classic case is the radio spectrum where, in the absence of agreement on allocation, there would be a degradation of the resources for all. In this case, the problem is fairly simple, because there is no territorial location of the spectrum and there are no production costs or environmental consequences of use. International agreements also have been used to regulate some ocean fisheries in order to sustain their physical yield. Such agreements usually maintain the stock of fish, but at the cost of great economic inefficiency in harvesting them. They work best when few countries are involved in the fishery; the agreements are vulnerable if outsiders choose to enter the fishery. Moreover, such agreements only regulate participation in the harvest, not the disposition of the catch.

INTERNATIONAL CONTROL OF SUPPLIES

The trading system allocates resources to those best able to buy; it is criticized because those with very low incomes are impotent in the market. The market system has also organized the supply response that, up to the present, has provided generally ample supplies to meet rising demand. For the moment, suppose that we have a world in which supply response is not possible—that we face severe and incurable shortages. In such a world, sellers would not need protection and the rich would still preempt supplies (although a new group—i.e., Arabs—might be the rich). In a world of relatively fixed supply, is an international organization needed to allocate it?

It is still possible to argue that bidding in the market should determine the distribution of that fixed supply and that any international organization should simply promote free trade. Few would have qualms if the market were distributing nonessential commodities. But essential natural resources may be seen in a different category, like food in wartime. If resources are to move across borders at all under conditions of scarcity and in the presence of continued income inequality, a controlling international organization would have to seek a formula judged more equitable than the ability to pay.

Conceivably the international organization could apply a different standard. Viewing natural resources largely as intermediate products to be used in further production, it might seek an allocation that directed them to the places where they would be most productive. It is unclear at this point whether that would diminish or accentuate income inequalities. In any case, it is not an obvious standard of fairness.

PER CAPITA EQUALIZATION

Returning to the egalitarian premise and the as-

sumption of a fixed supply, an agency would very likely allocate supply on the basis of population. Is one human being less deserving of his ration than another? A major complication is the vast physical and economic differences between countries. A level of energy supply sufficient for the needs of a backward tropical country might leave an advanced northern industrial country freezing in the dark. Perhaps formulas could be attempted to account for the physical differences between countries. They would have to be very complicated indeed, allowing for differences in such parameters as temperature, topography, population distribution, and many others. Per capita resource allocation could also have perverse effects on income by making the premise about fixed resource supplies a self-fulfilling prophecy. The countries with high incomes and high per capita consumption are also the source of the capital and technology needed in any effort to increase supply.

The most difficult philosophical problem in any per capita equalization scheme among nations is that, under conditions of fixed resource supply, rapid population growth in one country dilutes the welfare of its neighbor. Logically, international control of population growth should accompany resource control. At present there are huge discrepancies in population growth rates. Moreover, population policy is a highly emotional issue in some countries, and national attitudes and policies toward growth are extremely variable. International control of both population and resources seems to lie in the future.

Assuming that the egalitarian principle is accepted, how far does it go? For example, would the internal distribution of scarce resources remain a national matter? In a world where resource use and incomes were equalized among nations, the egalitarian pressure easily could extend across borders into the internal distribution within the nation. And if scarce resources are to be allocated in this way among and within nations, how about another class of consumers—posterity? By what standard are they provided for? If we think of resources as a fixed stock, then the number of generations provided for becomes a very arbitrary decision. If resources are not a fixed stock, then attention to increasing supply may be more useful than refining allocation formulas.

Since resource use is so closely bound up with living standards, industrial strength, and national power, an egalitarian system of allocation presumes a world at peace with little rivalry and with fairly equal living standards. Moreover, if a nation must surrender control over resource supply, and perhaps over population policy and internal income distribution, then its sovereignty is severely abridged. Domestic economic policy would have a restricted field of play, although there might still be opportunities to promote more efficient adaptation to a world of shortage.

Obviously, we are discussing a very different world from the one we know; at present national sovereignty is still the key rule and great differences prevail among countries regarding income, technical development, and attitudes. It may be argued that the imperatives of the world situation will compel the submergence of these differences. But realistically, the changes required to make an international organization workable surely will take decades, as a minimum, and the end result might be a type of homogenization that few would welcome.

AN ALTERNATIVE APPROACH

The image of a world of fixed supplies in which some egalitarian means of sharing is required may not be the appropriate one. If resources are seen as an expandable continuing supply rather than a fixed and limited stock, then some of the difficult issues of redistribution between nations and generations can be avoided. In this light, the emphasis could be placed on supply rather than on allocation. True, continued population growth, the upgrading of per capita consumption worldwide to the level of developed countries, and continued increases in the per capita consumption of developed countries put enormous pressure on resource supplies. Even a global agency for allocating scarcity could not cope with endless population growth. Thus the supply option assumes an end to population growth and some dampening and leveling of income. It could take two paths, both heavily dependent on technology and economics.

One means of increasing supply is to produce from lower quality resources. We have done this in the United States already in the case of iron ore, and on a world basis there are many examples, especially copper, gold, and tin. For most minerals, the total amount contained in known leaner ores is many times the amount found in currently commercial ores. We mine the richer ores first because they yield materials at lowest cost. As these become scarcer, increased price or technological progress in mining and processing makes it commercially feasible to produce from the more abundant leaner ores. Over a long period of time, increased scarcity has been more than balanced by technical progress; the real costs of minerals have remained fairly constant or falling, and supplies have been abundant. Even if this trend should not continue, it is still possible to increase supply at higher cost. Note that the historical result of abundant supply at stable cost was obtained without the intervention of an international authority. However, this success depended on the availability of ample, albeit lower quality, resources.

However, not all resources occur in increasing amounts at lower grades. Some, particularly fossil fuels, are not dispersed in this manner and face more defined resource limits. Although some deposits of

oil or coal that presently are not workable may be rendered exploitable by price increases or technical advance, this does not necessarily increase the size of the resource substantially. Moreover, fuels are destroyed in use and do not reappear for recycling. Some of the nonfuel minerals are rare components of the earth's crust, and, as a practical matter, we may not have access to much larger supplies. Thus, society cannot indefinitely continue to rely on exhaustible supplies of fuels and certain rare minerals. In these cases, technology should develop substitutes. So far, we can only dimly see the shape of these—perhaps fusion as an ultimate energy source, and basic research to find substitutes for rare metals.

Whether we increase supply by making use of inferior ores or by substituting other sources, the net result is to escape the constraints of a fixed stock. It is very expensive to develop and deploy the new technology and often the investments are international in character. The scale required to meet world aspirations may strain the financial means and planning horizons of private firms. In addition, the benefits of the new technology cannot be confined to those who develop it. In view of this, is there a role here for an international organization whose stress would be on the development rather than on the allocation of scarce resources?

If the organization were in the business of allocating resources it would face a range of problems relating to supply and price that could be avoided if it were simply a production agency. If it were the latter, then it could seek to supply whatever the market would take at an average price sufficient to meet total costs. Under this regime, the market would also determine the level of supply. Costs might rise with increased output and, with incomes still unequal, some could afford to buy more than others, so resource use would not be equal. But other means could be sought to redress income differences. With resources viewed as the expandable product of man's ingenuity and investment rather than as an immutably fixed stock, it is hard to see why they should be rationed by any means other than the market.

If we do not rely on the market to determine the amount supplied and its distribution, then there will be great tension between those favoring more supply at a higher price and those favoring lesser supplies at a lower price allocated by some rationing formula. Conceivably, an international agency could pick its way through this by price discrimination favoring low income buyers while still permitting a larger supply to those willing to pay more, but this might engender severe resentment on the part of those who subsidize the low income buyers.

An agency seeking to expand supply through new technology and the use of inferior resources would

need a strong research component and a capability for mobilizing investment funds. Both of these are to be found principally in the developed countries that would suffer from income redistribution schemes or from restrictive supply strategies. The organization might become self-financing over time, assuming a full-cost pricing policy, but for a long while it could not afford to forego the whole-hearted financial and technical support of developed countries. This is more likely to be forthcoming if the agency follows a policy of nondiscriminatory pricing and aggressive supply—in brief, a policy that does not by itself equalize resource use.

Even so, the agency would encounter major conflicts. Many individual countries have a vested interest in mineral production or have resources of potential commercial value. There would be much internal struggle within the agency over research strategies that might render these resources obsolete or bring them into production. How responsive would the agency be to the concern of governments about the effect of its actions on their economies? And if it were responsive, could it also be an efficient producer deserving the support of its wider consumer constituency?

The world is perverse enough to support an opposite possibility—that governments will seek to have production located elsewhere. Resource production often entails extensive landscape or other environmental damage, and resort to leaner ores may magnify this problem, as disproportionately more material is processed to gain the resource sought. Lower grade ores and substitute resources may be widely dispersed, and there may be no compelling reason to choose one site rather than another. If access to materials were unrelated to the site of production, then pressure could be applied to have production sited elsewhere. Already this can be seen in the United States, where few communities are willing to host a power plant that serves a wider area. This concern about the environmental consequences of resource production could reflect on the decision about the pace of expansion. While it has been suggested that the level of supply could be determined by market demand, in practice, environmental concern may restrict supply below that level.

Given these potential sources of conflict, it is legitimate to ask whether an international agency is the best vehicle for developing new supply, assuming a commitment to a strategy of increasing supply rather than of allocating shortage. It would be inherently unwieldy and inflexible. Yet in its absence, would private firms or individual governments have the resources and take a long enough view to provide for future supply? Certainly few governments hold such promise. Most respond to very short-term pressures and are subject to budget constraints that pre-

vent them from making the long-term investments needed.

It is possible to imagine a consortium of governments, particularly of like-minded developed countries, forming an organization to secure future supplies, but a global organization is more difficult to envisage. A narrower grouping of developed countries would have both the financial and technical resources and similar perceptions of the problem. However, they would be subject to the charge of insensitivity to the needs of less developed countries, including present resource producers.

Oddly enough, the much-maligned multinational firms may have a useful role to play in a supply strategy. They dispose of considerable financial and technical resources and their worldwide interests have sensitized them to the views of many countries. The difficulty with them, however, is precisely the one that all lament—no one really controls them. The temptation for still more powerful multinational firms to manipulate resource prices to their own advantage might overcome the most ethical executives. There is no assurance that they will meet social objectives.

COOPERATION RATHER THAN CONTROL

One can imagine a global resource organization playing an important role in future resource development, but it might be a somewhat less monolithic endeavor than is implied by the word "control." As a start, such an organization could serve as a clearing house for exchanges of technical information, or it could engage in cooperative research. It could monitor world trends and indicate where supply problems are likely to occur. It could foster agreements on nondiscriminatory trading and help to stabilize the conditions under which exchanges occur. It could also seek wider agreement on the terms of foreign investments within resource industries. But it would leave individual nations, groups of nations, and private firms free to devise their own programs of supply and to operate in markets according to the agreed rules.

Such a system would be far more flexible than one where decisions were centralized in an international agency torn by diverse interests. The emphasis would

(Continued on page 53)

Sterling Brubaker has written on the world aluminum industry and has studied problems of resource development in Latin America. His two most recent books, *To Live on Earth: Man and His Environment in Perspective* (Baltimore: Johns Hopkins University Press, 1972), and *In Command of Tomorrow: Resource and Environmental Strategies for Americans* (Baltimore: Johns Hopkins University Press, 1975) have discussed longer-term environmental and resource problems.

BOOK REVIEWS

Readings on Food and Energy: Part II

- Paddock, William and Paul. *Famine—1975*. Boston: Little Brown, 1967.
- Pearson, Lester B. (chairman). *Partners in Development: A Report of the Commission on International Development*. New York, 1969.
- Piotrow, Phyllis T. *World Population Crisis: The United States Response*. New York: Praeger, 1973.
- Polach, J. G. "The Development of Energy in East Europe." U.S. Congress, Joint Economic Committee, *Economic Development in Countries of Eastern Europe*. Washington, D.C., 1970.
- Pollack, Gerald A. "The Economic Consequences of the Energy Crisis," *Foreign Affairs*, April, 1974.
- President's Science Advisory Committee. *The World Food Problem*, vol. 2, Washington, D.C., May, 1967.
- The Progressive*, eds. *The Crisis of Survival*. New York: William Morrow, 1970.
- Ridgeway, James. *The Last Play: The Struggle to Monopolize the World's Energy Resources*. New York: Dutton, 1973.
- Rifai, Taki. *The Pricing of Crude Oil: Economic and Strategic Guidelines for an International Energy Policy*. New York: Praeger, 1974.
- Robbins, William. *The American Food Scandal*. New York: William Morrow, 1974.
- Rocks, L. and R. P. Runyon. *The Energy Crisis*. New York: Crown, 1972.
- Rothman, Milton A. *Energy and the Future*. New York: Franklin Watts, 1975.
- Rouhani, Fuad. *A History of O.P.E.C.* New York: Praeger, 1971.
- Sánchez-Albornoz, Nicolás. *The Populatio of Latin America: A History*. Berkeley: University of California Press, 1974.
- Sanderson, Fred H. "The Great Food Fumble." *Science*, May 9, 1975.
- Schertz, Lyle P. *Economics of Protein Improvement Programs in the Lower Income Countries*. No. FEDR-11. U.S. Department of Agriculture. Washington, D.C., June, 1971.
- . "World Food Prices and the Poor." *Foreign Affairs*, April, 1974.
- Schmandt, Jurgen. *One Aspect of the Energy Crisis: The Unbalanced State of Energy, R & D*. Austin, Tex.: Lyndon B. Johnson School of Public Affairs, 1972.
- Schmidt, Helmut. "The Struggle for the World Product," *Foreign Affairs*, April, 1974.
- Schultz, Theodore. *Economic Crises in World Agriculture*. Ann Arbor: University of Michigan Press, 1965.
- . *Economic Growth and Agriculture*. New York: McGraw-Hill, 1968.
- Scott, Anthony D. *The Economics of Conservation*. Buffalo, N.Y.: Books Canada, 1973.
- Schurr, Sam H. and Paul T. Homan. *Middle Eastern Oil and the Western World*. New York: American Elsevier, 1971.
- Stakman, E. C. et al. *Campaigns Against Hunger*. Cambridge: Belknap Press, 1967.
- Starratt, Patricia E. *The Natural Gas Shortage and the Congress*. Washington, D.C.: American Enterprise Institute, 1974.
- Steele, Henry B. and Dankwart Rustow. *Oil Imports and the National Interest*. New York: Petroleum Industry Research Foundation, March, 1971.
- Stocking, George W. *Middle East Oil*. Kingsport, Tenn.: Vanderbilt University Press, 1970.
- Stonier, Tom. "An International Solar Energy Development Decade." *Bulletin of the Atomic Scientists*, May, 1972.
- Study of Critical Environmental Problems. Work Group on Energy Products. *Man's Impact on the Global Environment: Assessment and Recommendations for Action*. Cambridge: MIT Press, 1970.
- Tai, Hung-chao. *Land Reform and Politics: A Comparative Analysis*. Berkeley: University of California Press, 1974.
- Tanzer, Michael. *The Energy Crisis, World Struggle for Power and Wealth*. New York: Monthly Review Press, 1974.
- Teller, Edward. *Energy: A Plan for Action*. New York: Commission on Critical Choices for Americans, 1975.
- Theobald, P. K. *Energy Resources of the United States*. U.S. Geological Survey Circular 650, 1972.
- Thirring, Hans. *Energy for Man: Windmills to Nuclear Power*. Westport, Conn.: Greenwood Press, 1968.
- Toward the Integration of World Agriculture: A Tripartite Report by Fourteen Experts from North America, The European Community and Japan*. Washington, D.C.: Brookings, 1973.
- Trade in Primary Commodities: Conflict or Cooperation*. Washington, D.C.: Brookings, 1974.
- United Nations. "Permanent Sovereignty Over Natural Resources." U.N. Secretary General's Report, September 30, 1974. Also see subsequent report of January 31, 1975.
- . *The World Food Conference*. Rome, 1974. Also see the U.N. Publications Office for material from the various U.N. agencies, e.g., the Foreign Agriculture Office, the International Labor Organization, the Economic Commissions for Asia and the Far East, Europe, Latin America, and Africa. For original source material the annual statistical abstracts published by the U.N. are invaluable.
- United States. See the U.S. Government Printing Office for list of available publications on world resources.
- Vansant, Carl. *Strategic Energy Supply and National Scarcity*. New York: Praeger, 1971.
- Walters, H. *The World Food Situation*. National Agricultural Outlook Conference, December, 1974.
- Ward, Barbara and René Dubos. *Only One Earth: The Care and Maintenance of a Small Planet*. New York: Norton, 1972.
- World Food Problem, Report of the President's Science Advisory Commission (1967)*, vol. 3. Cambridge: Harvard Center for Population Studies Reprint, 1967.
- Yager, Joseph A. and Eleanor Steinberg. *Energy and U.S. Foreign Policy*. Cambridge: Ballinger, 1974.
- Young, L. B. *Power over People*. New York: Oxford University Press, 1973.

VIRGINIA C. KNIGHT

(Part I of this List appeared in our June, 1975, issue)

AMERICA'S FUTURE IN ENERGY

(Continued from page 5)

are simply educated guesses and are juggled and manipulated to suit the interests of those who make or use them. Moreover, even if the estimates were accurate, they do not reveal how much energy it will cost to obtain each additional unit of energy recovered. On a world basis, there is still no shortage of either oil or natural gas, but the United States is clearly on the downward slope with regard to both of these. It should be the chief aim of Project Independence to make that slope as gradual as possible by eliminating waste and by allocating the reserves to less damaging end uses. We can reduce waste or poor allocation by using a holistic approach to the problem.

Our most important natural resource is topsoil, with water a close second; both are essential to life and to our ability to obtain energy from our only continuous source of energy, the sun. The greatest resource in our topsoil is the worm who makes new topsoil very slowly, yet our energy intensive agriculture steadily destroys both topsoil and worms. The National Academy of Science says that one-third of our topsoil is already gone. Much of this was lost by erosion even before 1940, when our wasteful use of energy in agriculture began to destroy the texture and the vital organisms of topsoil.

Agriculture is a key to the energy crisis. Even before the New Deal, American agriculture sought high output per man-hour of work by labor-saving machinery that was destructive of the land and gave a low output per acre. During the New Deal, the federal government paid farmers to withdraw land from cultivation, turning agriculture toward high-energy patterns which meant less labor and less acreage, but more capital per acre to get high yields. This required so much capital that many families could not afford it, so food production was taken over by corporations and agribusiness, owned by conglomerates and energy companies. Organic manures were replaced by artificial fertilizers made from fossil fuels, chiefly natural gas. Mixed farming was replaced by hybrid monoculture that required enormous inputs of fertilizers, pesticides, herbicides, and drugs, mostly made from fossil fuels that polluted the environment with great damage to the natural organisms in the soil. As a result, farming today uses more petroleum than any other single industry in the United States; the input of energy must increase every year to maintain the same high yields. In Illinois, in 1949, 20,000 tons of fertilizer produced 50 bushels of corn per acre, but in 1968, it required thirty times as much fertilizer (600,000 tons) to get 93 bushels per acre. Because of rising costs, the

farmer had to produce 80 bushels per acre just to break even.

Agriculture used to capture energy from the sun so that men and animals could work. Today, more than ten calories of energy must be put into farming for every calorie that comes out. Now one man can care for up to 75,000 chickens, or 5,000 feed-lot cattle, or 50 milk cows, on farms run as specialized plants. At the same time, the children of former farmers are on relief without work, decent food or even heat, and are destructively unhappy, in northern cities (more than one million persons were on relief in New York City in April, 1975). As one consequence, crime and violence are making our cities uninhabitable. This must be regarded as a cost of our high-energy agricultural system. We must also include as costs the government agricultural subsidies and the farm corporation tax benefits that propel our whole food system along this destructive road.

Between 1945 and 1970, corn yields increased 240 percent, from 34 to 81 bushels per acre, while labor used decreased 60 percent, from 23 hours per acre each year to only 9 hours. At the same time, fertilizer input increased from 19 pounds per acre to 203 pounds, and drying energy (because hybrid corn is too moist) went up from 4,000 to 120,000 kilocalories per acre. The total energy input per acre of corn in 1970 reached 2.9 million kilocalories, equal to 80 gallons of gasoline, up from 0.9 million kilocalories in 1945.

For biological reasons, the excess use of hybrid seed is self-defeating and dangerous over the long run (say 25 years) because hybrid seed is bred for an increasingly artificial environment, including soil oversaturated with nitrogen and other pollutants. It is also incapable of performing well in the natural environment, because its genetic strain is too narrowly specialized. As a result, natural pests can adapt to it so well, by natural selection, that they can wipe out a major part of the crop after a few years.

At present, the American public, including Secretary of Agriculture Earl Butz and most scientists, does not recognize the dangers inherent in our high-energy agribusiness system, but the situation is increasingly ominous. Disaster can be avoided only if the rising costs of energy force us back toward an organic, more labor-intensive farming system, replacing monoculture with a more diversified system. More than a million kilocalories per acre could be saved and soil conditions could be improved with a great reduction of pollution if we replaced artificial fertilizer by manure and decentralized feedlots. If we could restore crop rotation with winter legumes (used as fodder), we could save 1.5 million kilocalories per acre more in energy and would improve both the soil and human diets. Replacing herbicides with a rotary hoe could save 10 percent energy in weed con-

trol, and the use of biological pest controls instead of chemicals would save more. If pesticides were applied only as needed, rather than routinely, energy costs would be reduced 35 percent, while doing this by hand rather than by machine would reduce energy for this from 18,000 to 300 kilocalories per acre. Almost total abandonment of chemical farming would reduce food output 5 percent, would increase farm prices 16 percent. (the same amount they fell in the year March, 1974, to March, 1975), and would increase farm income about 25 percent, would bring much unused farm land back into cultivation, and would save vast sums in government subsidies. It would also encourage unemployed city dwellers, or at least their children, to return to rural areas, with some savings in welfare costs.

Just as government subsidies and special-interest tax benefits have made agriculture wasteful of energy, so they have also given us a wasteful transportation system. If, for example, tax rules required depreciation over the life of the equipment, and if energy costs rose, producers would turn from wasteful to energy-efficient methods. Similarly, our transportation system would have been much more careful about wasting energy if the government did not subsidize wasteful modes of transportation, like airlines, keeping their fares down, while refusing to help energy-efficient modes of transportation and allowing their fares to rise. Forty-one percent of all our energy in 1972 went to transportation. The most efficient way to move goods is by pipeline, at 450 Btu. a ton-mile, and the least efficient is airfreight, at 4,200 Btu. a ton-mile. Railroads move freight for 670 Btu. a ton mile; competing trucks use 2,800 Btu. a ton-mile. Over 20 years, from 1950 to 1970, railroad efficiency increased from 3,045 to 670 Btu. while in the same years truck efficiency decreased from 2,400 Btu. to 2,800 Btu. Yet railroads were hampered by public policy; trucking and airlines were encouraged and subsidized.

Moving people has been just as wasteful. Auto travel in general moves people at an energy cost of 5,400 Btu. per passenger-mile, exceeded only by autos in cities, at 8,100 Btu. and airlines, at 8,400 Btu. Between cities, railroads move people for 2,900 Btu. a passenger-mile; buses use 1,600; and private automobiles use 3,400 Btu. a passenger-mile. In cities, mass transit moves people at 3,800 Btu. a mile each, less than half the automobile cost of 8,100 Btu. Yet government subsidies have consistently gone to the most wasteful; an annual subsidy estimated at \$38,000 a year goes to each private business turbojet plane. More than 80 percent of the federal transportation budget has gone to highways and airports, while only 5 percent has gone to mass transit and railways. At

the same time, regulatory agencies, chiefly the Interstate Commerce Commission, have allowed railroads to destroy their passenger service and to neglect their tracks and equipment so that these have now dangerously deteriorated, and have driven passengers from buses and railroads to private autos and airplanes by allowing air fares to increase only 8 percent during 1950-1970 compared to increases of 90 percent in buses and 40 percent in rail fares.

The drive toward private profit is also apparent in the search for new oil reserves. Petroleum corporations say that if they are allowed to make outrageous profits and freed from any concern about the environment, they will increase their exploration for new petroleum reserves and will find enough to meet our most wasteful desires. This is sheer propaganda. For more than 50 years, oil companies have enjoyed profits and freedom from environmental restraints equalled by few other corporations, yet their discoveries of new reserves and new pools of oil have been decreasing. Instead of using profits for the domestic exploration for new reserves, petroleum firms have sent their profits overseas or have used them in this country to take over other businesses like our largest circus, our chief motel chains, our largest coal mines, and much agribusiness.

But even if all oil company profits were devoted to seeking new petroleum resources, the rate of discovery of new reserves is not likely to grow. The consensus among serious students of the subject, like the National Petroleum Council, the American Association of Petroleum Geologists, and a recent committee of the National Academy of Sciences, is that we used more than half our total recoverable supply of oil in the period from 1856 to 1974 (100 billion barrels), and have a smaller total remaining, which can be extracted only at constantly increasing costs in both energy and money. Off-shore oil exploration is too expensive when both immediate and holistic costs are considered.

The solution is to devote less money to seeking new oil pools and to devote more money to achieving a higher rate of extraction from known oil pools, since the rate of "recovery" is now only about 30 percent. If we could secure a larger part of the oil we know is in the ground, by raising the recovery rate to 35 percent or more, and, at the same time, if we could increase the efficiency with which we use petroleum (eliminating waste and needless or damaging uses, as in agriculture), we could help to close the petroleum gap from both ends. At present, 80 percent of the energy in gasoline is wasted.

A recent article in *Science* by R. R. Berg et al. says: "Oil recovery methods capable of recovering a high percentage of the oil remaining in abandoned fields are known."⁷ Such fields could be reactivated as the price of oil rises.

⁷ R. R. Berg et al., *Science*, April 19, 1974, pp. 331-336.

The other "exciting new source" of oil is the oil shales of the Rocky Mountains (Colorado). Here the technology for extraction of oil is known and could be covered by an oil price of about \$6 a barrel from the best shale. But the total costs in money or resources are so large that no extensive exploitation is likely unless the government subsidizes production. It would be far better to use public money for energy conservation, subsidizing mass transportation or providing low-cost loans to insulate homes heated by natural gas. The fuel in oil shale is kerogen, which exists in very small amounts in the rock (usually far less than 30 gallons per ton), so that tons of shale have to be dug out, transported, processed with heat, and disposed of for each barrel of oil recovered. The energy needed to extract the oil is likely to be greater than the energy in the oil recovered.

The costs to the community are also very formidable. The rocky residue that must be disposed of after extraction is full of salts. Present plans are to dump this in nearby canyons, but even if enough canyon capacity is found, the debris would have to be leveled, to prevent sliding, and would have to be covered, to prevent blowing. It would have to be covered with topsoil, which is in short supply in the area, and the topsoil would have to be held down by vegetation. It is very unlikely that local vegetation would grow, because the debris is too salty, and the local rainfall is below 15 inches a year. Such scanty precipitation is not sufficient to establish vegetation, but unfortunately it is enough to leach out the salts, so that the salinity of the Colorado River at Hoover Dam might increase by 50 percent. This would increase the costs of desalinization downstream, where there is already an excessive demand and an insufficient supply of residential and irrigation water. Since the most promising shale area is now only scantily inhabited, although it is within 100 miles of the ski resort at Aspen, homes, roads, stores, schools, hospitals, and other facilities for workers would add to the costs of this enterprise. And local wildlife would be exterminated.⁸

The voting population of Colorado will not accept this development without a struggle. Nonetheless, the corporations concerned hope to obtain government subsidies large enough to make the experiment profitable with little regard for its impact on the area. Even if the environmental problem is ignored, the net yield of energy will be so small, the costs of extracting the shale and dumping the debris are so great, and the water supply is so inadequate that oil shale offers little help in solving the energy crisis, especially

in comparison with the coal in the same area, which will be competing for the same inadequate supply of water.

The United States has plenty of coal. The size of its reserves can be judged from the fact that the energy content of our coal is at least 18 times that of the Arab oil reserves. It has been estimated that if West Europe and Japan obtain two-thirds of their energy needs from the Middle East, the Arab oil would last about 23 years, but if United States coal were consumed at the same rate, it would last over 600 years. The real problem is not the supply of coal but how to get it out of the ground with the maximum gain in net energy and with the minimum damage to the land and the people.

Over the last 50 years, coal has not been able to compete with oil in convenience or in price, even with great sacrifice of the land, the coal field environment, and the health and lives of the miners. Strip-mining, even without regard to environmental damage, could not drive the price of coal low enough to compete successfully with oil. The new leaders of the once corrupt United Mine Workers Union are determined to improve the conditions of deep-mine workers. At the same time, it is impossible to continue to destroy the land by strip-mining, because the costs of the damage, including the loss of topsoil and the danger of increasing dust storms in the West, would become too large to bear. In 1970, the cost of deep-mined coal was \$7.40 a ton compared to \$4.69 for stripped coal, and 44 percent of all American coal was produced by stripping.⁹ The costs of reclaiming the land after stripping can run up to \$2,700 an acre or more, but if the surface is too sloped, or the climate is too dry, or the underground streams (aquifers) are destroyed by the stripping, it may be impossible to rehabilitate the land at all.

Unfortunately, the best remaining coal reserve in the world, the very thick, low-sulfur deposits of our northern Great Plains, lie where the rains are eight to fifteen inches a year and the aquifers run through the coal. Moreover, this is also our region of high and fairly constant winds, which is why W. E. Heronemus of the University of Massachusetts has suggested the plains as the proper place for windmill power. When the sod of the plains was broken for wheat farming in World War I, the subsequent dust storms darkened the skies at noon as far away as Chicago. This was one of the reasons the New Deal paid farmers to withdraw these lands from planting. In 1971, the United States government secretly opened those lands to enormous strip-mining projects that cover over 250,000 square miles of land, to generate electricity on the sites and send it by wires over thousands of miles of 765,000 volt transmission lines. All environmental damage and all wastes, including enormous ash residues, were ignored. The

⁸ W. D. Metz, "Oil Shale," reprinted from an article in *Science*, April 19, 1974 in Abelson, *op. cit.*

⁹ Jane Stein, "Coal Is Cheap, Hated, Abundant, Filthy, Needed," *Smithsonian*, February, 1973, pp. 18-27.

first step of the project will produce 50,000 megawatts by 1980, stripping up to 30 square miles a year to obtain 210 million tons of coal by using 855,000 acre-feet of water. The plants are to operate for 35 years, destroying more than 50,000 square miles of surface.

This North Central Power Project is already being constructed, and probably cannot be stopped or substantially modified by judicial action, since the Supreme Court, in March, 1975, refused to stop a similar project, known as the Four Corners Project, on the much drier southern plains where Colorado and Arizona meet. The more northern project will probably have to be forced to cover the external social costs by legislative action. But timely action is unlikely, because the energy-utility interests almost totally control the executive branch of the federal government and are very influential in Congress. The operators would have to be required to operate deep mines or to guarantee the total rehabilitation of strip-mined areas (probably impossible if the aquifers are destroyed, as they may be). Moreover, the wasteful generation and transmission of electricity should be replaced, as far as possible, by methods more economical of coal, energy, and water, like the gasification of the coal, which provides energy at about half the cost in water. The energy losses in moving gas in pipes, further, is only a minute fraction of the energy costs of moving electricity. Moreover, power lines deface the landscape and dangerously affect the atmospheric ozone balance.

If deep-mined coal is used instead of stripped coal, the immediate costs will be greater; if stripped surfaces are rehabilitated, the increased cost of the coal might be 50¢ a ton. Nonetheless, the costs of any energy production must be borne by the American people. It is wiser for society to pay more for coal mined under better conditions than to produce coal at a lower money cost and pay great social costs later.

It is possible that much Great Plains coal could be left in the ground if we use the coal that now pours out of Norfolk, Virginia, to foreign countries. Norfolk's abundant water and coal could be used to make gas, methane, hydrogen, and even electricity, all of which could be distributed more cheaply than Great Plains coal by expanding existing pipelines and electric power lines to energy-short areas.¹⁰ The argument against this, that we need the foreign exchange we get from coal sales abroad, is worthless. Our foreign exchange problems can be resolved more effectively by financial measures. And the political security of the world could be improved if Japan took over our share of the Middle East oil and obtained her coal from other areas, like China.

¹⁰ A. M. Josephy, "Agony of the Northern Plains," *Audubon*, July, 1973, pp. 68-101.

An increase in net energy from coal should be regarded as a transitional stage, perhaps of long duration (up to 60 years or so), toward a new energy system based on cleaner, more economical energy, like hydrogen, methanol, methane, and other gases or liquids, distributed by pipelines or tanks instead of wires. There should also be a substantial shift away from airplanes and private vehicles toward mass transit, railroads, and buses, and the present wasteful cross-traffic of both goods and people should be reduced, to produce a healthier and happier society. There should be more autonomous and decentralized communities, in which people are closer to nature and to each other, and are less concerned with spectator activities, and increasingly involved in community activities, including food production and the essential cycles of nature. Spectator activities and mercenary armies have always been the key symptoms of a society in decay. They can be avoided by wise energy decisions. ■

THE OIL-DEPENDENT DEVELOPING COUNTRIES

(Continued from page 24)

depletable resources will be eased. At the other end of the research scale, attention should be directed to the widespread needs for energy in small scale and diffuse uses. A fourth factor is the global scope of the environmental impact that the energy policies of individual countries, or industrial firms within them, are causing. Oil spills in the oceans and radiation levels in the atmosphere cannot be safely left to decisions at a national—or industrial—level.

Whether there is a possible and practical level at which energy policy can be coordinated internationally is a question that is just beginning to be seriously addressed. Limiting factors and conflicting interests crowd in on all sides when the possibility is raised. But the underlying urgencies remain. Perhaps international coordination could usefully be explored in a framework analogous in some ways to that now being worked out for food. The World Food Conference in Rome, in 1974, brought together all sectors of the world community—the U.S.S.R. and the People's Republic of China included—to approach a worldwide problem in global terms. Goals were set and means were proposed for dealing with them in various time frames. Institutions covering the major facets of the food scene and involving all the key participants were proposed and accepted. Whether this kind of approach could be applied to world energy problems is worth exploring. The shock of the OPEC action may prove to have opened up an awareness of the global energy predicament in a constructive way. ■

OIL AND THE MEMBERS OF OPEC

(Continued from page 9)

cent of its needs for these commodities, according to the specific resource.

There are also specific aims of the producers and of the consumers that need not be competitive but can be complementary. At OPEC's March, 1975, Algiers session, two areas had special producer implications. First, OPEC seeks to have a major portion of new petrochemical and fertilizer plants and oil refineries constructed in the member countries, with the industrialized nations guaranteeing the access for the products of such facilities in the advanced consumer markets. Second, OPEC is anxious to secure adequate protection against depreciation in the value of its members' external capital reserves, along with security for their investment.

These goals can mesh with two primary concerns of the industrialized oil importers. With closer marketing ties in petroleum products between OPEC and the countries of the Organization for Economic Cooperation and Development (OECD), the security of the oil supply should be enhanced by increased mutuality of economic interests and reciprocities. Additionally, the OPEC drive toward security and stability in the value of investment supports the push by the industrialized nations to curb inflation and, in the process, to provide a basis for greater stability in oil prices. Unfortunately, the mutuality of consumer-producer interests has been clouded by the initial tendency toward confrontation, in part spawned by the political atmosphere surrounding the 1973 oil embargo. The confrontation impulse led to a counterproductive stance, for example, in the 1974 United States Trade Act, which excluded all OPEC members from the American system of trade preferences (most-favored-nation). Obviously, Nigeria, Iran, Indonesia, Venezuela, Ecuador and Gabon had not participated in the embargo for which this exclusion was designed as punishment. Moreover, the Arab OPEC members were currently supplying the United States with petroleum. It is instructive that President Gerald Ford, in his State of the World address of April 10, 1975, asked Congress to provide executive authority to waive those restrictions in the Trade Act incompatible with United States national interests.

The failure of the initial producer-consumer meeting in Paris during April, 1975, should not be regarded as a complete breakdown in the establishment of a dialogue. Hopefully, there will be a diminution of the type of careless word play demonstrated by

a high American official who, on the eve of the Paris meeting, described the United States goal as one of accelerating "OPEC's demise" at that session.

Economic ties should be forged between OPEC and consumer nations in trade and investment as well as in energy. These ties can best be forged in an atmosphere of reciprocity and mutual respect. Singling out OPEC as the cause of the various economic woes of the world may impede the structuring of global economic interdependence; but it cannot basically alter the reality of that interdependence. ■

ENERGY IN THE SOVIET UNION

(Continued from page 14)

tween demand and supply by a massive energy flow to widely separated markets; and Soviet planners are faced with the technological, economic and logistic tasks of directing this flow overland by pipelines and rails from sparsely populated supply areas with an uncommonly harsh environment. Can this be done? Are the resources there, and can they be transported? What is the technological lead time that controls their exploitation and delivery?

In sum, the Soviet Union unquestionably has greater fossil fuel and water power potential than any other state; this seems true of prospected and proved fuel reserves. When reserves and transportability of specific energy sources are considered, however, this enviable situation is somewhat altered. At present rates of exploitation, proved resources of coal would last for hundreds of years and resources of gas for almost 70 years,²² although the delivery of these fuels to centers of demand poses problems that are far from solved. Reserves of oil, the most versatile and transportable fuel, are shrouded in mystery. But recent official pronouncements have expressed some concern about the adequacy of proved crude oil supplies to meet growing demand after the current decade. The reserves-to-production ratio has been declining since the late 1960's, although new discoveries since 1970 may have arrested the decline.²³ With

²² Production in 1974 amounted to 261 billion cubic meters. Proved reserves by 1973 exceeded 18,000 billion cubic meters. A U.N. report places reserves at 20.5 trillion cubic meters, but only 3/5 of this is considered recoverable. *Ekonomicheskaya gazeta*, no. 5 (January, 1975), p. 5; *Gazovaya promyshlennost'*, no. 3 (1972), p. 46 and "UN Report on Natural Gas," *UN Economic and Social Council*, Ref. G/R4 (September, 1973).

²³ A number of Soviet sources concerning such a decline are cited in *Exploitation of Siberia's Natural Resources*, pp. 76, 110 and 111. The latest Western estimate by the U.S. assistant secretary for energy and trade, based on talks with Soviet officials in February, 1975, places proved reserves in the U.S.S.R. as 75 billion barrels, i.e., 10.3 billion tons, which would be equivalent to a 23 years reserve to production ratio. U.S. reserves are around 35 billion barrels. *The Christian Science Monitor*, February 25, 1975, p. 4. In 1970, the Soviet oil minister stated that the reserves to production ratio was around 25 to 1. "Soviet Oil to 1980," *The Economist Intelligence Unit*, QER Special no. 14 (June, 1973), p. 3.

Erratum: We regret that a typographical error appeared in the article by Fred H. Sanderson, in our June issue, on page 267. In line 6 of the right column, the sentence should read: "The 15 percent difference in projected population. . . ."

over one-third of the world's sedimentary areas in that vast country, Soviet chances for additional big oil finds should, of course, be good, while new recovery techniques may boost existing reserves.

In examining Soviet energy supplies, however, one must look not merely at the size of resources, but also at their location, transportability, and costs to consumers, and the technological lead time that controls their exploitation and delivery. Production of all fuels in the European Soviet Union can only be increased by a fraction of the expected increment in demand. Because of the slow construction of collieries during the past decade, the output of Donets steam coal in the 1970's cannot be increased by more than 15 million to 20 million tons. New capacity increases of 30 million tons are now under way, but further big expansion seems to entail unacceptable costs and risks to human life.²⁴ The enlargement of supplies of other solid fuels in the European U.S.S.R. are being vigorously urged. Yet, except for the Pechora coal field beyond the Arctic Circle, none of these supplies are physically capable of large increments in output. The flow of oil and gas has now peaked from most fields west of the Urals.²⁵ Recent oil finds in the area can only compensate for declining production in older petroleum reservoirs, although some expansion of gas production is possible.

The burden of dramatically expanding Soviet fuel supplies must fall on the Asiatic and particularly the Siberian regions. The biggest supplies of cheap fuels

—too poor in quality for other uses but capable of raising steam and generating electricity at uncommonly low costs—are the immense reserves of surface lignite and coal in south-central Siberia (the Kansk-Achinsk basin) and East Kazakhstan (the Ekibastuz-Maikuben field). These very cheap boiler fuels, however, are largely immobile. Kansk-Achinsk lignite does not yield to briquetting, is liable to self-combustion, and thus is impossible to haul beyond short distances, while the high ash content of Ekibastuz coal prevents its transportation beyond the western slopes of the Urals. Of all the eastern coals, only Kuzbas coal can be moved west of the Volga, doubling in cost by the time it reaches Moscow. But even at this cost, no more than 25 million to 35 million tons of it can be made available for these regions, although this may double in the distant future.²⁶ Really massive fuel transport to regions west of the Urals, therefore, must come from deposits of gas and oil, which are more mobile forms of energy with higher calorific content.

Of the total proved and semi-proved Soviet gas reserves (twice as large as those of the United States), four-fifths are found beyond the Urals and Caspian, and roughly 70 percent are concentrated in the permafrost-ridden wilderness of northwest Siberia.²⁷ Despite the arctic conditions and the 1,800–2,000-mile distance to consumer centers west of the Urals, the delivered price of this gas is still lower than the price of coal in nearly all the European provinces.²⁸ Yet most of these vast reserves are still shut in, with only 18 billion cubic meters produced there in 1973.²⁹ Even when full capacity is finally reached on the recently completed West Siberia-Moscow trunkline, the total delivery from this region to European Russia and the Urals combined will amount to no more than 40 billion cubic meters.³⁰ To speed up the exploitation of these fields, the Soviet Union is prepared to barter large quantities of gas for pipes; it has signed a number of such contracts with West European firms.³¹ Still, considering construction experience both in the U.S.S.R. and the American Arctic, it is inconceivable that more than three 48- or 56 inch gas pipelines could be in operation from Siberia to regions west of the Urals before the next decade. In addition to Siberia, Soviet Central Asia (formerly Turkestan) pipes over 50 billion cubic meters to European Russia and the Urals, but this flow is unlikely to increase by more than 50 percent.³²

The relatively better located Siberian oil fields will obviously have to shoulder the lion's share of the increment in Soviet fuel supply in the 1970's. The roadless, primeval swamp of the Middle Ob Basin presents tremendous obstacles to resource development (the cost of road construction can reach 0.5 million rubles per kilometer; dozens of tractors disappear in the marsh each year; drilling crews must

²⁴ N. Khudosovtsev, "Ugol'naiia promyshlennost' Ukrainy . . .," *Ekonomika Sovetskoi Ukrainy*, no. 8 (1973), pp. 12–13 and 28; and M. Tikhonov and S. Polevoi, "Nekotorye voprosy ratsional'nogo ispol'zovaniia toplivnykh resursov URSR," *Ekonomika Sovetskoi Ukrainy*, no. 8 (1974), pp. 6–7.

²⁵ For a detailed survey of oil production from the various petroleum provinces, see "Soviet Oil to 1980," *op. cit.*, pp. 6–18.

²⁶ K. M. Zvyagintseva, "On the Three Fuel and Energy Supply Zones of Siberia," *SG:RT*, vol. 15, no. 8 (October, 1974), pp. 494–95. Although some 80 million tons of Kuzbas coal (3/5 of total output) moves out of Siberia, over 35 million tons of that is coking coal sent mostly to the Urals, and much of the steam coal shipped out also goes to the latter region.

²⁷ *Pravda*, August 22, 1973, p. 2; *Izvestiia*, March 23, p. 3 and reference 22.

²⁸ Probst, *op. cit.* (Puti razvitiia . . .), pp. 56–57 and N. V. Mel'nikov, *Mineral'noe toplivo* (Moscow: "Nedra," 1971), p. 183.

²⁹ *Ekonomicheskaiia gazeta*, no. 6 (February, 1975), p. 3.

³⁰ *Izvestiia*, October 26, 1974, pp. 1–2 and T. Shabad, "News Notes," *SG:RT*, vol. 16, no. 2 (February, 1975), p. 121. A 48-inch line can carry 15 billion cubic meters; a 56-inch line can carry upward to 28 billion cubic meters. Mel'nikov, *op. cit.*, p. 182.

³¹ See for example, Moscow Narodny Bank, *Press Bulletin*, June 19, 1974, pp. 4–5; October 9, 1974, pp. 5–6; November 20, 1974, p. 10 and December 11, 1974, pp. 3–5.

³² *Izvestiia*, September 22, p. 3 and T. Shabad, "News Notes," *SG:RT*, vol. 15, no. 7 (September, 1974), pp. 442–43.

work from man-made islands that take years to build). Nonetheless, the main oil reserves are found south of the permafrost boundary at fairly shallow depth and are very prolific. West Siberia is scheduled to produce over 146 million tons of oil in 1975 (the 1973 output was 116 million) and, with perhaps 270 million to 300 million tons, should provide over two-fifths of Soviet petroleum by 1980.³³ A 44,200 kilometer system of mostly large-diameter pipelines has now been completed, to be expanded to almost 47,000 kilometers by 1976; this will make possible the transportation of nine-tenths of all crude output by this cheapest overland method.³⁴

Based on these figures and on the necessary lead time for future pipeline construction, one may estimate that the total amount of liquid and gaseous fuels that Soviet Asia can deliver to the Urals and westward should reach 280 million to 290 million tons of standard ton equivalent in 1975 and 460 million to 480 million five years later. While this flow is sufficient to cover the fuel deficit in the European U.S.S.R. and most of the deficit in East Central Europe, it cannot, in my view, sustain at the same time the present or enlarged oil export to hard currency areas. For a deeper understanding of the Soviet energy economy, one must balance the import needs of East Europe, the Soviet commitment to the area, and the comparative advantage of Soviet fuels, particularly oil, on the world market.

With roughly three-tenths of the Soviet economic

³³ *Ekonomicheskaya gazeta*, no. 3 (January, 1974), pp. 1-2 and "USSR Bright Energy Prospect," *Energy Policy*, vol. 2, no. 4 (December, 1974), p. 350.

³⁴ *Ibid.*, p. 2 and "Soviet Oil to 1980," *op. cit.*, pp. 19-20 and 24.

³⁵ Growth rates of these countries' GNP's (without the service sector) are given in *Statisticheskii ezhegodnik stran chlenov SEV*, 1971, p. 43 and . . . , 1974, p. 45. The GNP weights were taken from F. Kozma, *A "Ket Europa" gazdasagi kapcsolatai es a socialista nemzetközi együttműködés* (Budapest: "Kossuth," 1970), pp. 148 and 302.

³⁶ *Nafta Broj* (Zagreb), no. 10 (October, 1973), p. 552 and Kozlov and Shmakova, *op. cit.*, p. 25. Again, the two sources give close results.

³⁷ *Nafta Broj*, p. 553 and Kozlov and Shmakova, *op. cit.*, p. 28.

³⁸ V. Suprun, "Uluchshenie mezhdunarodnoi spetsializatsii . . .," *Ekonomika Sovetskoi Ukrainy*, no. 1 (1974), p. 71. However, since total petroleum consumption in 1973 reached only 14.6 million tons, the 6 million tons for the chemical industry seems too high. But even in other sectors, while yielding smaller savings, a ton of oil can replace nearly 4 tons of East German lignite. The GDR still produces a million tons of petroleum feedstocks via the hydrogenation of lignite, but this process is now regarded as a highly uneconomic operation and may be abandoned before long. *Statistisches Jahrbuch der Deutschen Demokratischen Republik* (Berlin, 1974), pp. 125, 300 and 303 and *Petroleum Press Service*, September, 1973, p. 337.

³⁹ *Statisticheskii ezhegodnik stran chlenov SEV*, 1973, pp. 84 and 341-98. Also Scanlan, *op. cit.*, p. 100.

⁴⁰ Scanlan, *op. cit.*, pp. 100-102; Nepszabadsag (Budapest), January 23, 1974, p. 10; and I. Dobozi, "Az energiahordozok a KGST gazdasagaban," *Valosag* no. 1, 1973, p. 22.

capacity, the CMEA countries of East Europe achieved an eight percent growth rate of their combined GNP since 1960, according to official data.³⁵ This high rate of development was accomplished with a yearly expansion of primary energy input averaging only 4.4 percent during the 1960's.³⁶ As in the Soviet Union, the increased economic productivity per unit of gross energy input was made possible by a shift to more efficient fuels, although—more so than in the U.S.S.R.—greater emphasis on less energy-intensive light industries, consumer goods and services also aided the process.

The energy mix of East Europe, however, is still strongly dominated by solid fuels, among which low calorific lignites play a particularly important role. As late as 1970, petroleum and gas furnished not much more than one-fourth of all primary energy (in 1960, only one-tenth), and in the three most industrialized countries (East Germany, Czechoslovakia, Poland) their share amounted to 20 percent or less.³⁷ The technological and environmental burden from such a fuel mix is shown by the example of East Germany. Six million tons of Soviet oil in the East German petrochemical and synthetic material industries is claimed to replace upward of 100 million tons of lignites,³⁸ two-fifths of current output from strip mines, where the ratio of overburden to coal now exceeds 5 to 1. Radical expansion of the coal and lignite output in Czechoslovakia is still more difficult, and only Poland, in all of East Europe, has really large reserves.

A further growth of petroleum and gas consumption at a rate outpacing that of total energy demand, therefore, seems inevitable. In the past 15 years, East Europe has largely completed the dieselization and electrification of its railroads. However, a significant part of its chemical industry (where the replacement of solid fuels yields particularly large benefits) is still not based on petrochemical feedstocks; the majority of households still burn coal and lignite; while increasing truck transport and the motorization of the populace continues to augment the demand for refinery products.

Excepting Romania, these countries are woefully deficient in hydrocarbon fuels; for the remaining five, indigenous supplies accounted for only 13 percent of all petroleum and two-thirds of natural gas consumption in the early 1970's.³⁹ Given the low share of liquid and gaseous fuels in East Europe's fuel balance, and given the strain on the region's energy reserves in general, a huge increase in that deficit is unavoidable. Various authorities, including East European scholars, expect the current net import of oil and gas (exceeding 54 million tons of oil equivalent or 80 million tons of standard fuel in 1973) to more than double by 1980,⁴⁰ and recent dramatic developments in the world energy market

have not changed this gloomy forecast. Until 1973, the U.S.S.R. met virtually all of East Europe's petroleum deficit, since imports from third world countries were almost entirely compensated for by exports or refined products to the West.⁴¹ East Europe's growing petroleum need was instrumental in the sharp reduction of net Soviet export to countries outside the bloc since the mid-1960's. In 1973, almost 27 percent of such exports were counterbalanced by imports from North Africa and the Middle East (chiefly Libya and Iraq), representing barter trade for goods and military supplies and payment for technical assistance.⁴²

Whether the U.S.S.R. will maintain or increase deliveries to its CMEA partners, in view of the quadrupling of the value of oil on the Western markets, is thus a significant factor in the future pattern of Soviet energy policy. It is clear that East Europe is unable to shoulder the full burden of Western price levels, and the U.S.S.R. will have to forego real economic benefits from any oil supplied to the CMEA rather than to the West. As expected, a huge price rise was indeed enforced on Russian oil for East Europe (a 1.3-fold increase, from 16 to 37 rubles; \$21.50 and \$49.50 at the official exchange rate).⁴³ However, the new price is still one-third below the world price level, although it may now be more frequently renegotiated and not fixed, as it was before, for five-year periods. From now on, East Europeans must also invest heavily in Soviet production and

refining facilities to secure adequate energy supplies.⁴⁴

Of late, the U.S.S.R. has been vigorously prodding its partners to broaden their sources of petroleum supply, but the limits of this course are obvious. In 1973, East Europe imported 16 million tons of crude oil directly from third world countries. Almost as much is already contracted for annual delivery by the late 1970's,⁴⁵ but it is very doubtful that much more is within the financial capabilities of these states. Unless world oil prices collapse, the political and strategic interests of the U.S.S.R. in East Europe will probably make further increases in crude oil deliveries to this region unavoidable, although at a slower rate,⁴⁶ and with a possibly growing portion of it originating in Arab countries in exchange for military and other supplies that the small countries of the CMEA cannot themselves provide. Whatever the size of future oil exports, however, Russian natural gas supplies to East Europe are due for a very large increase. During the 1975-1980 period, a total of 33 billion cubic meters are committed (average of 6.6 billion per year) and plans for 1980 envisage a flow of over 21 billion cubic meters annually.⁴⁷

CONCLUSION

In the U.S.S.R., with state ownership of the means of production and a strongly centralized system of resource allocation, the reconciliation of various objectives, demands and needs, the short and the long run, all must take place on the highest level and must be incorporated into national planning. This is certainly true of energy decisions, since the mobilization of energy resources provides one of the most vital underpinnings of a country's economic and military strength. In the forthcoming years, quoting a comment by a perceptive press columnist, Moscow planners must:

balance at the same time a strategic interest in remaining the principal supplier of oil to Eastern Europe; the purely commercial interest in getting higher prices that Western countries will pay for energy; and the ultimately all-important self interest of expanding the Soviet economic base at a satisfactory rate.⁴⁸

Soviet planners intend to make greater efforts at fuel conservation at home and will probably increase somewhat the export of oil to the West this year. However, such increases will probably be limited, particularly with the developing oil glut on the world market, and the large shut-in capacity of major supplying nations. There is also evidence that the U.S.S.R. is very reluctant to make long-term commitments on petroleum deliveries, although it is willing to do so for natural gas, coal from some fields, and ores.⁴⁹ In addition, Russian prevarication with Japan over the supply of Siberian oil and gas (now practically a dead issue except for off-shore develop-

⁴¹ *Petroleum Press Service*, May, 1973, pp. 169-70 and *Statisticheskii ezhegodnik stran chlenov SEV*, 1974, pp. 341-98.

⁴² *The Petroleum Economist*, June, 1974, pp. 204-205.

⁴³ *The Christian Science Monitor*, February 24, 1975, p. 6 and *The New York Times*, January 28, p. 3.

⁴⁴ In addition to shouldering much of the cost of the pipeline system from beyond the Volga to Central Europe, the countries of East Europe must now provide credit for and participate in the production of Siberian oil and gas. Already Czechoslovakia and the GDR have had to agree, the former providing 4 billion korunas (over 500 million rubles) for the Tiumen fields, to be paid back by petroleum deliveries during the 1971-84 period. Suprun, *op. cit.*, p. 72 and V. Dan'shina and L. Iashina, "Chekhoslovakia na puti sotsialisticheskoi integratsii," *Planovoe khoziaistvo*, no. 5, 1974, pp. 88-89.

⁴⁵ *The Petroleum Economist*, June, 1974, p. 205 and March, 1974, p. 113; Moscow Narodny Bank, *Press Bulletin*, November 27, 1974, p. 7 and other sources.

⁴⁶ During the 1970-74 period, the Russians clearly had to put East European needs higher on their priority scale. Despite bitter complaints, exports to CMEA partners soared while those to West Europe, particularly France, fell far short of the amount contracted. *The Oil and Gas Journal*, July 15, 1974, p. 25. The Time-Post Service recently reported that an official of the foreign trade association for petroleum, Soizneftexport, declared: "Export of oil from the USSR to socialist countries will continue growing." Reprinted in the *Vancouver Sun*, February 18, 1975, p. 38.

⁴⁷ *Figyelő* (Budapest), May 8, 1974, p. 7 and Moscow Narodny Bank, *Press Bulletin*, June 19, 1974, pp. 4-5.

⁴⁸ Peter Osnos of the Time-Post Service. As reprinted in the *Vancouver Sun*, February 18, 1975, p. 38.

ment near Sakhalin) and the current economic chills resulting from Soviet hostility to the rapprochement and projected friendship treaty between Japan and China⁵⁰ suggest caution in assessing Soviet objectives with the yardstick of economic benefits and costs.

Soviet strategic interest in the political stability and economic viability of East Europe will continue, and so will Soviet oil exports, still below world prices. Such exports may even grow, although much greater expansion will take place in the delivery of natural gas. At any rate, the entire CMEA industrial potential will probably be much more closely coordinated, and more of East Europe's strength will be harnessed for the development of Soviet natural resources.

Because of mounting resource scarcity (true or perceived), insecurity of supplies, and the consequent disarray among industrial powers, Soviet leaders are expected to place increasing value on their energy and other mineral riches. The U.S.S.R. (with some East European help) is obviously able to develop these resources with or without Western assistance, and is determined to do so. Soviet confidence in the strength of the Soviet position has been clearly vindicated by the \$9 billion credit recently arranged primarily from West European sources.⁵¹ Soviet resource development and the modernization of the economy will forge ahead on Soviet terms, with political and strategic interests inviolate, and the long-term stability of the system the paramount goal. ■

⁴⁹ *Ibid.* See also comments of A. Belchuk, head of the Institute of World Economics and International Relations of the Soviet Academy of Sciences, at the Soviet-West German conference on trade as reported in *Ecotass*, November 11, 1974 and Moscow Narodny Bank, *Press Bulletin*, November 27, 1974, pp. 3 and 7.

⁵⁰ *The Christian Science Monitor*, February 19, 1975, p. 3 and *The Financial Times*, January 17, 1975.

⁵¹ *Ibid.*, February 25, 1975, p. 4.

WEST EUROPE, JAPAN AND AUSTRALASIA

(Continued from page 18)

cision to act—or not to act—on cooperative energy research and development programs is clearly of fundamental importance.

Another policy decision facing these industrialized countries—along with North America—is whether they wish to attempt to negotiate an international oil agreement with the oil producing nations who are members of the Organization of Petroleum Exporting Countries (OPEC). The historical record of efforts to negotiate and implement international commodity agreements is not encouraging. And there are objections to commodity agreements (which inevitably involve a negotiated price) on grounds that such agreements would distort competitive forces in the

marketplace. Nevertheless, if a commodity agreement could somehow be negotiated by the oil-producing and oil-importing nations, it could in principle provide the basis for a more stable world oil market and, conceivably, for a more rational approach to the development of the world's various energy resources.

In addition to agreeing on the nature and extent of mutual cooperation in energy matters, most OECD energy importing countries face long-term decisions on the amount of energy they will import from China, the Soviet Union, and East Europe. These decisions are long range because they involve long-term bilateral commitments that, in many cases, include substantial exports of capital and technology to the Soviet Union and possibly China, in exchange for an assured quantity of energy imports over a period of years.

Japan has been exploring with the U.S.S.R. a number of possible deals involving Siberian oil and gas resources and is expanding her imports of oil from China. A number of West European countries have entered into long-term agreements with the U.S.S.R. with regard to imports of natural gas. Soviet natural gas will be flowing into West Germany, Italy, France and elsewhere in Europe by the early 1980's; the question is whether and by how much to expand further imports from the Soviet Union.

In terms both of their short-run objective of reducing their dependence on oil and of their long-run goal of developing new energy resources to replace fossil fuels as these resources become depleted; the industrialized nations must decide on the extent to which they wish to promote and expand nuclear power. Nuclear power, which for years has been expected to be "the next fuel after fossil fuels," has not come into widespread use as rapidly as once had been anticipated. In addition to the technical difficulties that plague power plant operations and the environmental and safety concerns mentioned earlier, there is the potential threat of nuclear power to world security.

A POTENTIAL THREAT

Briefly, the threat is that both plutonium, a by-product of current power plant operations and potentially a source of reactor fuel, and highly enriched uranium, which will be used as fuel in the high temperature gas reactors expected to go into commercial use in the late 1970's, may be diverted to build nuclear bombs, or may be used in attempts at international political blackmail. With regard to the short-run objective of reducing dependence on oil imports, it is important to note that nuclear power plants typically have a long gestation period (seven to ten years) between their initial planning and their full-scale commercial operation. Thus, expanding nuclear power cannot help to reduce oil imports in the near future. As to the long-run objective of de-

veloping new energy sources, decisions on funding the development of new reactor technologies (the liquid metal fast breeder reactor, for example) must be made in conjunction with research and development funding for other new energy sources. These decisions can be made either by individual nations, which means that only a few rich, technologically advanced nations will participate in the decision, or multilaterally—for example, though the International Energy Agency.

In summary, the OECD nations outside North America are very much dependent on energy imports. Over the next decade, they must decide on the amount and kinds of international cooperation on energy matters they are willing to undertake. Unlike the United States and Canada, which at least in theory could come close to energy self-sufficiency over the next ten years or so, most of these countries must import a large proportion of their energy requirements. In this context, Japan and most of the countries of West Europe must develop energy policies with respect to other energy importing nations and with respect to the countries of OPEC. Finally, they must decide now which future sources of energy they want to emphasize in their funding of energy research and development programs, in order to prepare for the time when oil and natural gas resources are depleted. ■

ALTERNATIVE ENERGY SOURCES

(Continued from page 36)

solar water and space heating will probably be competitive with conventional methods of heating in some areas. However, a number of institutional barriers will have to be overcome. Solar cooling should also be able to compete with cooling systems using conventional fuels, but this development will take somewhat longer.

Wind energy could also be utilized at some locations. Nonetheless, because of the large awkward equipment needed to produce even limited amounts of useful energy from this source, its widespread application is unlikely.

Other methods for using solar energy will require large-scale and long periods of research and development before solar energy will be able to compete with other fuel resources, even if the research should be successful.

GEOHERMAL ENERGY

Geothermal energy has been produced commercially since the turn of the century, and small quantities of electricity have been produced from geothermal resources in a number of countries. There are a variety of different types of geothermal energy resources, but most of the electricity has been generated from the type known as vapor-dominated, naturally generated

steam. Liquid-dominated systems have been used for space heating, the heating of greenhouses and for process heat for preparing paper, salt and diatomite.

As long as only the vapor-dominated geothermal systems appeared to be economically attractive, there was only a mild interest in developing geothermal resources, which are found in limited quantities. As conventional fuel prices have increased sharply, other types of geothermal resources have received increased attention. These include hot water systems, geopressure and hot rock geothermal deposits.

The temperature of hot water geothermal systems is different for each deposit, but those in the Imperial Valley of California, the largest deposits in the United States, have a temperature range of 350°F to 600°F. The water also has a wide range of dissolved salts; some deposits are essentially fresh water and others contain as much as 20 to 30 percent of dissolved salts. Hot water systems can be utilized in two ways. In one, steam is flashed from the hot water and used to generate electricity in a low pressure steam turbine. In the other, the hot water transfers its heat, through a heat exchanger, to a lower boiling liquid (such as isobutane or freon), which is then expanded in a special turbine to generate electricity.

The steam flashing method of using hot water deposits results in a more concentrated salt solution of the remaining water so that the water must be returned underground to prevent water pollution on the surface. Moreover, if the water contains noxious fumes, they are released during flashing and must be treated to prevent air pollution. Because of the low steam temperatures, the steam turbines are very large per unit of electricity generated, and difficult erosion problems have been encountered in the later steam turbine stages.

The two-fluid heat-exchange method of using hot water deposits avoids most of these problems, but it requires additional equipment over that needed by the steam flashing system.

Hot water deposits that are also under high pressure and frequently contain dissolved natural gas have been discovered around the shores of the Gulf of Mexico. The water temperature is about 400°F, and the water is at pressures of 10,000 to 18,000 pounds per square inch. Very little research has been done on ways to exploit these resources, and a method is needed that will utilize all three forms of energy they contain—hot water, high pressure water and dissolved natural gas.

Although the extent of the resource is unknown, the heat contained in dry hot rocks that are found near the earth's surface represents potential energy. These hot rocks are the magma from the molten center of the earth, which have penetrated to near the surface and have been trapped there. At shallow depths, the temperature of these rocks are expected to be in the range of 275°F to 325°F. Methods need to be found

to identify the location of such deposits by surface measurements and to make an inventory of their occurrence. If large amounts of energy are to be recovered from this type of resource, methods to utilize it must be devised.

One method of using such deposits would drill two holes from the surface to the hot rock. Water would be introduced into one hole, would be converted to steam by the hot rock and would be removed as steam from the second drill hole. However, it is improbable that the hot rocks are permeable enough naturally to permit the generated steam to flow through them from one drill hole to another. Some preliminary tests have been made to determine whether sufficient permeability can be achieved between drill holes by the spalling action that cold water would have on the hot rocks. If this is not successful, either conventional or nuclear explosives could be used to shatter the rock between the inlet and outlet holes. It is apparent that the many technical unknowns involved in rock penetration and heat transfer make commercial appraisal impossible at this time.

TIDAL ENERGY

Although there have been many suggestions for the development of specific tidal bays where the tidal range is large, along most of the coasts of the world the range between high and low tides is too small to be useful for generating electricity. The most attractive North American sites are Passamaquoddy Bay (jointly bounded by the United States and Canada), the Cook Inlet in the Gulf of Alaska, and the Bay of Fundy in Canada. The total potential of these sites has been estimated to be as high as 50 billion kilowatts per year or about 2.5 percent of the United States and Canadian electricity consumption in 1974. Individual sites may prove to be worth developing, but the total contribution of tidal energy to United States supplies will always remain small. Realistically, tidal power would probably be able to provide only about 0.2 percent of the energy required in 1985.

There is some uncertainty about when the world will need to turn to renewable resources to satisfy its needs for energy, since both the size of the ultimately recoverable resources of the nonrenewable fuels and the rate at which they will be used is unknown. However, a number of alternative resources are available in almost unlimited amounts, some of which could be used for energy when the nonrenewable resources are no longer adequate.

Some of these new resources could be developed very quickly; others will require long periods of highly complex and sophisticated research and development. Unfortunately, resources that could be brought into commercial use rapidly apparently will not be able to satisfy all man's energy demands when the production of nonrenewable fuels begins to decline. A long-term

commitment must be made to develop the other, more-difficult-to-develop resources, if there is to be sufficient energy to supply man's needs in the next century. The OPEC oil embargo of 1973 demonstrated how dependent a nation is on energy resources. As a result, the United States has greatly expanded its research and development efforts with regard to renewable resources and has made a commitment to bring these resources into commercial use when they are needed. ■

INTERNATIONAL CONTROLS?

(Continued from page 41)

be on agreed rules. It might or might not stress free trade and competitive pricing. If an attempt were made to alter the terms of trade for resource commodities, it could improve incomes in the LDC's, but it would still be far from a resource equalization scheme. However, if technology is our ultimate resource and if income differences represent differences in productivity, then the exchange of technology and encouragement to capital transfers might do more to equalize income than any conceivable resource allocation scheme. ■

CHINA'S ENERGY RESOURCES AND PROSPECTS

(Continued from page 27)

using the percentage increments of GNP and energy production, by dividing 33.7 percent by 40.2 percent one can obtain the figure of .84. This figure (.84) measures the percent increase in energy products required for every one percent increase in GNP and may be described as the income elasticity of energy demand. Since further economic development in China will probably increase the proportion of commodities requiring petroleum and other energy products as raw materials (not to mention increasing fuel consumption for power and transportation), one probably should expect a larger value of elasticity of energy demand than the .84 derived above, assuming the figure to be at all close to the real value.

We can arrive at different estimates of China's rising energy requirements in 1970-1973 by setting the value of elasticity of demand for energy products at either 1 or 1.1 and by adopting different rates of GNP growth for this period.

At a five percent GNP growth and an energy demand elasticity of 1.1, we arrive at a total energy demand for 1973 equal to 440 million metric tons of standard "coal equivalent." Alternatively, at an eight percent annual GNP growth and an energy demand elasticity of one, the corresponding total energy demand in 1973 would equal 360 million tons of coal equivalent. These two figures happen to bracket Smil's estimate of 393 million tons for domestic consumption in 1973. It appears that the

parameters we have adopted for estimating the relationship of energy demand and GNP growth in China are plausible. A four-to-five-million-ton crude oil export, which was attained in 1974 and was equivalent to 5.2 million to 6.5 million tons of standard coal, is nearly one and one-half percent of China's estimated total energy consumption in 1973. This is consistent with the proposition that an exportable energy surplus in the form of crude oil was only just emerging in 1973-74. Therefore, any expansion of oil export must be based upon the growth of this surplus starting from 1973 as a base.

Assuming a five percent GNP growth and an elasticity of energy demand equal to 1.1 (in order to allow for changes in technology and product mix), China's total energy demand would rise by 5.5 percent a year. During the 1960-1970 decade, coal, which accounted for 68.5 percent of the total energy consumed, rose by only 1.4 percent a year. Natural gas, which accounted for 15.2 percent of the total consumption in 1973, rose by 2.2 percent a year. Hydroelectricity, which was responsible for one-half of one percent of the total energy consumption, increased by 10.3 percent a year. If the same rates of increase in production are maintained for coal, natural gas and hydroelectricity, together they could provide for an increase of 1.33 percent of energy demand. Thus, there would be a deficit equal to 4.17 percent of the total energy demand of the base year, given the latter's rate of increase at 5.5 percent. Translated into coal equivalent, this is equal to 16.4 million tons for 1974, which can be converted into 12.6 million tons of crude oil. If the increase in crude oil production in 1974 over that of 1973 were as high as 20 million tons, then there should be an increment in exportable surplus equal to 7.4 million tons. If production in 1974 was only 60 million tons, as reported in *The New York Times* of February 10, 1975, this increment in exportable surplus over the 1973 level would disappear. Alternatively, if GNP growth were one percent higher and 1974 output was 70 million tons, the increment in exportable surplus would be reduced by 3.3 million tons, leaving a net amount of about 4 million tons available. For 1975, if the GNP growth continues at 5 to 6 percent and if the other energy sources fail to contribute an increasing share of the total energy demand, then domestic consumption will rise by 13 million to over 16 million tons of crude oil which will equal 18.6 to 23 percent of 70 million tons, the higher estimate of 1974 production. Whether China's oil production can increase by more than that amount becomes a crucial question. Is this possible? Vaclav Smil, for instance, has suggested a possible long-term growth rate of 11 to 13 percent a year. This would not be sufficient to maintain China's oil export even at the projected level of 8

million to 9 million tons in 1975, not to mention a rapidly expanding export, unless there is a spurt in production. Where might this bonanza occur?

The answer lies offshore. However, here we come face to face with the need for advanced technology and equipment, unless Chinese efforts in shallow waters close to shore will suffice. It goes without saying that such efforts, if successful, will entail the need to protect the offshore producing areas from sabotage and from possible enemy attack.

Finally, a word should be said about oil price. During the last quarter of 1974, when Japan's fear of shortage of oil was already being replaced by an actual oil glut, Chinese oil was still being sold to Japan at \$12.80 a barrel. This price may be compared with \$3.60 to \$3.80 a barrel in early 1973. Peking showed no hesitation in raising its oil price to the world level or even above it. More recently, the price has been reduced in the face of weakening demand as a result of the overall economic decline in some oil-importing countries. A 10 percent increase in oil export, if matched by a corresponding decline in price, would bring China no increase in foreign exchange earnings. At the rate of 7 barrels a ton and \$10 a barrel, every ton of oil exported would earn \$70. If 9 million tons are exported at an average price of \$10 a barrel, China should be able to earn \$630 million from her oil export in 1975. In the past, according to unpublished studies by the author and his associates, Chinese exports rose from \$140 million to \$200 million a year under favorable conditions. This amount could rise to \$300 million, given special efforts in export promotion. The addition of another \$600 million from oil exports could increase Chinese exports in 1975 by more than \$1 billion when compared with the preceding year, abstracting from the inflation factor. However, there is no guarantee that the same rate can be sustained.

Internationally, Peking must seriously consider the desirability of allowing Western technology and capital to enter the country on a larger scale. Domestically, China must consider a wider range of alternatives in economic planning. For instance, should China reduce energy export in order to produce more fertilizers at home, thus increasing domestic grain production and reducing net grain and fertilizer imports? A similar issue concerns the possibility of using energy products for synthetic fiber production, to reduce domestic consumption of cotton textiles. This would enable China either to export more cotton goods or to free land for more grain production and export. Consideration of all these possibilities, both internal and external, requires that China be ideologically less doctrinaire. It also requires that the leadership in Peking be politically more stable and therefore more secure in planning the country's economic future. ■

TWO MONTHS IN REVIEW

A Current History chronology covering the most important events of May and June, 1975, to provide a day-by-day summary of world affairs.

INTERNATIONAL

African Development Bank

May 11—At the conclusion of a 5-day session in Lagos, Nigeria, delegates of 37 African nations fail to agree on a new president for the African Development Bank; Tunisia's Abdelwahab Labidi will remain as president for at least another year.

Association of Southeast Asian Nations

May 15—Meeting in Kuala Lumpur, Malaysia, foreign ministers of Malaysia, Indonesia, the Philippines, Singapore and Thailand (the Association of Southeast Asian Nations) fail to complete their treaty of amity and cooperation and postpone the signing of the treaty.

Commonwealth of Nations

May 6—Meeting in Kingston, Jamaica, 33 heads of Commonwealth governments agree to tighten economic sanctions against Rhodesia to force Rhodesia's white minority government to negotiate with her black nationalists.

Council for Mutual Economic Assistance (Comecon)

June 24—The 29th session of Comecon opens in Budapest.

Cyprus Crisis

(See also *Cyprus*)

May 4—Meeting under the auspices of the U.N. in Vienna, Greek Cypriote leader Glafkos Clerides and Turkish Cypriote leader Rauf Denktash agree to reopen Nicosia airport. They have not reached agreement on the fate of 200,000 refugees on the island.

May 17—In Rome, talks begin between the foreign ministers of Greece and Turkey on the Cyprus situation for the first time in 9 months.

Disarmament

May 30—Representatives of 65 nations end a month-long review of the 5-year-old nuclear weapons ban treaty. Dissatisfaction with the failure of the U.S. and the U.S.S.R. to undertake new commitments to limit their nuclear arms is expressed by the majority, who are all non-nuclear nations.

Economic Community of West African States

May 28—Meeting in Lagos, Nigeria, leaders of 15 West African nations sign a treaty creating an economic grouping to be called the Economic Community of West African States; the 15 states have a combined population of 124 million.

European Economic Community (EEC)

(See also *United Kingdom, Great Britain*)

May 11—The 9 members of the European Common Market (EEC) sign a trade treaty with Israel that will gradually eliminate all protective tariffs between the EEC and Israel.

June 11—Some 150 technical experts from the EEC and

the Arab League begin discussions in Cairo on the possibility of economic, technical and cultural cooperation. The Arab-European conference opened yesterday.

June 12—The commission of the EEC approves an aid program for Portugal.

Greece asks for full membership in the EEC and suggests that Turkey apply also. Greece is an associate member of EEC.

International Bank for Reconstruction and Development (World Bank)

June 13—Meeting in Paris, the bank's 20-nation development committee agrees to establish a new lending facility to make up to \$1 billion in low-cost loans available to developing countries in 1975-1976. The U.S. refuses to contribute to the special fund.

International Energy Agency

May 27—At a meeting in Paris of the 18 members of the International Energy Agency (a group of major oil-consuming countries), U.S. Secretary of State Henry A. Kissinger calls for a new international energy policy.

International Whaling Commission

June 27—The Commission reduces catch quotas on the finback whale by 10,000 for next season, giving it almost total protection from hunters.

Middle East Crisis

May 18—Egyptian President Anwar el-Sadat ends a week-long trip to 4 Arab countries; speaking in Damascus, Syria, he says that he has a mandate to speak for the Arab world in his June 1 conference with U.S. President Gerald Ford in Salzburg, Austria.

June 12—At the end of a 3-day meeting between Jordan's King Hussein and Syrian President Hafez al-Assad, a plan is presented for the establishment of a permanent Joint High Commission to coordinate military, political, economic and cultural policies between Jordan and Syria.

June 15—The Israeli coastal town of Nahariy is hit by rockets fired from Lebanon.

Retaliating for a guerrilla attack on an Israeli frontier village that killed 2 Israelis, Israeli air force jets bomb guerrilla bases in southern Lebanon.

June 24—In Jerusalem, Israeli officials report that Israel has offered Egypt a 3- or 4-year disengagement agreement including a corridor through Sinai to an Abu Rudeis oilfield.

North Atlantic Treaty Organization (NATO)

May 29—At a meeting of NATO nations in Brussels, Portugal's Premier Vasco Goncalves asserts that Portugal is "a loyal European state and intends to remain a loyal NATO member."

May 30—At the close of NATO's 2-day conference, U.S. President Gerald Ford says that NATO allies regard the U.S. as a "firm and vigorous" ally.

Organization of American States (OAS)

May 17—In Washington, D.C., Argentina's ambassador to the United States, Alejandro Orfila, is elected Secretary General of the 24-member Organization of American States for a 5-year term.

Organization of Arab Petroleum Exporting Countries (OAPEC)

May 5—At the conclusion of a 2-day meeting, Arab oil ministers agree to compensate poorer Arab countries from an \$80-million fund for higher oil prices this year.

Organization of Petroleum Exporting Countries (OPEC)

June 9—Representatives of the 13 nations in OPEC agree that oil prices will henceforth be quoted in Special Drawing Rights, instead of in dollars.

June 11—At the close of their 3-day meeting in Libreville, Gabon, OPEC representatives declare that oil prices will rise when the 9-month price freeze ends October 1.

United Nations

June 6—A Security Council resolution imposing a mandatory arms embargo on South Africa is vetoed by Britain, France and the U.S.

U.S. Secretary of State Henry Kissinger warns that the U.S. will "strongly oppose" any attempt to deprive Israel of her General Assembly seat.

June 10—Secretary General Kurt Waldheim asks the Security Council for a 6-month extension of the mandate for a peace-keeping force on Cyprus.

June 19—Secretary General Waldheim, in Mexico City, opens an international conference on the status of women.

United Nations Law of the Sea Conference

May 9—The United Nations Law of the Sea Conference adjourns its 8-week second session in Geneva and schedules a 3d session for New York in the spring of 1976; the drafting of agreements has proceeded slowly.

West African Rice Development Association

June 5—The 15 members of the association (in the most populated area of Africa) agree to work toward a regional economic community. After 7 states ratify this general agreement, details will be worked out.

ARGENTINA

June 2—Minister of the Economy Alfredo Gomez Morales is replaced by Celestino Rodrigo, former under secretary of Social Security and protégé of José López Rega, the presidential secretary and social welfare minister.

June 5—The government revalues the peso; the official rate is raised from 15 pesos to the U.S. dollar to 30 pesos to the dollar.

June 6—President Isabel Martinez de Perón announces the government's decision to abandon wage guidelines in favor of negotiated wage increases between unions and business associations.

June 20—A ransom of more than \$60 million has been paid by the Bunge and Born Company for the release of 2 officials, Juan and Jorge Born, kidnapped in September, 1974.

June 27—Thousands of workers demonstrate to protest the government's austerity measures. Conservative trade unionists call for the resignation of Economics Minister Rodrigo and Social Welfare Minister Rega.

June 28—The demonstration ends.

President Perón denounces the labor unions' wage policies as irresponsible. She orders a rollback of salary hikes recently obtained by the unions.

June 29—Minister of Labor Ricardo Otero resigns.

AUSTRALIA

June 5—Prime Minister Gough Whitlam announces 12 changes in his Cabinet.

BELGIUM

June 7—The Belgian government decides to buy 102 F-16 jet fighter planes built by a U.S. company, General Dynamics of St. Louis, Missouri. Norway, Denmark and the Netherlands promised to buy the planes if Belgium did. In all, 306 planes will be purchased by the 4 NATO countries.

June 12—Parliament votes 112 to 91 to support Premier Leo Tindemans's decision to buy the U.S.-built jet planes.

BOLIVIA

(See also *U.S., Industry*)

May 16—An emergency Cabinet meeting is held following publication of a letter in which a United States concern, the Gulf Oil Corporation, admitted paying \$460,000 in bribes to government officials, including the late General René Barrientos Ortuño, President between 1966 and 1969.

May 20—The government places the local representative of Gulf Oil under house arrest, summons Gulf's American chairman to appear in court, and says that the company will be "criminally prosecuted" for making illegal political contributions. The government promises to arrest the officials who accepted the payoffs.

BRAZIL

June 27—The government signs a multibillion-dollar nuclear technology agreement with West Germany. The technology will be used to provide electric power in the major cities. Under U.S. pressure, the government promises not to use the technology to build atomic bombs or explosive devices.

BURMA

June 11—In Rangoon, government troops arrest over 200 students who have been demonstrating for 5 days.

CAMBODIA

(See also *U.S., Foreign Policy, Military*)

May 3—The 1st convoy of foreigners expelled from Cambodia arrives in Thailand.

May 5—In Washington, D.C., the U.S. State Department says that the Cambodian Communists have forcibly evacuated the entire population of Phnom Penh, Kompong Chang and Siem Reap.

May 7—The former acting head of state, Saukham Khoy, says that the Lon Nol government paid former President Lon Nol \$1 million to leave the country.

May 12—Cambodian soldiers board and seize an American merchant ship, the *Mayaguez*, and take captive the 39-member crew. (See *U.S., Foreign Policy*.)

May 18—Prince Norodom Sihanouk, chairman of the Cambodian National United Front, leaves Peking for a visit with North Korean Premier Kim Il Sung.

May 28—The government nationalizes the rubber industry.

June 12—According to *The New York Times*, the long march of nearly 2 million people from the cities to the countryside has ended.

CANADA

May 5—The government announces a 60 percent price increase for natural gas sold to U.S. consumers, effective November 1.

May 9—Secretary of State for External Affairs Allan J. MacEachen announces that the government has renewed the North American defense agreement.

CHINA

(See also *Philippines*)

May 10—Deputy Premier Teng Hsiao-ping leaves for a state visit to France. He is expected to meet with French President Valéry Giscard d'Estaing and Premier Jacques Chirac.

CYPRUS

(See also *Intl, Cyprus Crisis*)

June 9—Results of the June 8 referendum show that 99.4 percent of the Turkish Cypriotes who voted were in favor of the constitution that established a Turkish state in northern Cyprus.

CZECHOSLOVAKIA

May 27—The Central Committee of the Communist party names Gustav Husak, party general secretary, to succeed the ailing President, Ludvik Svoboda.

DAHOMY

June 21—President Mathieu Kerekou and his bodyguard shoot and kill Interior Minister Michel Aikpe in his home.

DOMINICAN REPUBLIC

May 10—Minister for the Armed Forces Admiral Ramón Jimenez and the chiefs of the armed forces resign to protest the policies of President Joaquin Balaguer.

June 2—Citing dissatisfaction with the government, 4 service chiefs resign.

June 7—In a joint communiqué, the armed forces and police say that a left-wing guerrilla group has entered the country from Cuba. Troops are sent to an area west of Santo Domingo.

EGYPT

(See also *Intl, Middle East; U.S., Foreign Policy*)

May 1—In a May Day speech in Assiut, President Anwar Sadat announces that the U.S.S.R. has refused his request to delay Egyptian payments on the \$4-billion to \$7-billion debt owed to the Soviet Union.

June 5—President Anwar Sadat officially reopens the Suez Canal, closed since the 1967 war, to all but Israel-bound ships.

ETHIOPIA

May 27—Eritrean rebels and government troops agree to a peace plan proposed by the Sudanese government.

June 4—Heavy fighting is reported between government troops and followers of Arioslam Aultam in the eastern part of the country.

The government reports severe drought and famine in the Ogaden region, where Somalia and Ethiopia share a common border.

FINLAND

June 4—Premier Kalevi Sorsa's 4-party coalition Cabinet resigns because of increasing economic pressures. General elections will be held September 21 and 22.

June 14—President Urho Kekkonen appoints a caretaker Cabinet of civil servants until the general election.

FRANCE

(See also *Intl, NATO; Belgium, China, Iran*)

May 8—On the 30th anniversary of the end of World War II in Europe, President Valéry Giscard d'Estaing announces that there will be no future V-E Day celebrations in France.

May 9—President Giscard announces France's re-entry into the European currency bloc.

June 3—The government announces measures to curb inflation, including price controls, cuts in the prices of petroleum products, and incentives for hiring young workers.

June 6—A U.S. accounting firm reveals that General Paul Stehlin, a vice president of the National Assembly and a harsh critic of the French-built Mirage jet planes, has been on the payroll of the Northrop Corporation, a U.S. manufacturer of the YF-17 fighter plane.

June 12—In Paris, thousands of workers demonstrate to protest rising unemployment and plant closings.

June 15—Premier Jacques Chirac resigns as secretary general of the Gaullist party.

GERMANY, FEDERAL REPUBLIC OF (West)

(See also *Brazil*)

May 21—Trial begins for 4 accused terrorists, members of the so-called Baader-Meinhof gang, thought to have been involved in the March kidnapping of a West Berlin mayoral candidate and the April attack on the embassy in Stockholm.

GREECE

(See also *Intl, Cyprus Crisis; Turkey*)

June 7—Parliament approves a new constitution that provides for a system of checks and balances between the executive and legislative branches. Opposition members boycotted the voting session.

June 19—Parliament elects Constantine Tsatsos as the 1st President under the new constitution.

HONDURAS

June 14—It is announced that effective June 1, 29 army officers were retired by younger officers, who are demanding an end to corruption.

HUNGARY

May 15—The Presidential Council announces the resignation of Premier Jeno Fock and the appointment of Gyorgy Lazar, Deputy Premier and chief economic planner, as his successor.

INDIA

June 12—The High Court of Allahabad rules that Prime Minister Indira Gandhi won her seat in Parliament illegally in 1971. Under the law, she must resign her post and is barred from political office for 6 years. The judge grants her a 20-day stay to allow her to appeal to the Supreme Court.

Gandhi promises to fight the court ruling and stay in office.

June 13—In a joint statement, 4 opposition parties demand Gandhi's immediate resignation.

June 18—The ruling Congress party adopts a resolution declaring Prime Minister Gandhi's leadership "indispensable."

June 24—The Supreme Court rules that Gandhi can retain her post as Prime Minister but cannot vote in Parliament while her case is under review.

June 26—In New Delhi, a government spokesman says that 676 of Gandhi's prominent political opponents, including Jaya Prakash Narayan, have been arrested because of a "grave internal threat" to the 28-year-old republic. A state of emergency is declared. Censorship is imposed.

June 27—The Information Ministry reports that an additional 200 persons have been arrested.

June 28—It is reported in New Delhi that Ajitnath Ray, the chief justice of the Supreme Court, has resigned.

June 29—In New Delhi, rioters against the government battle police.

June 30—*The New York Times* reports that several political opponents of Gandhi have been shot and killed by government police in the eastern state of Bihar.

IRAN

May 15—In Washington, D.C., Shah Mohammed Riza Pahlevi meets with U.S. President Gerald Ford.

May 20—In Paris, Shah Pahlevi meets with French President Valéry Giscard d'Estaing.

May 21—In Teheran, 2 U.S. air force officers are shot and killed by terrorists belonging to a group called the Iranian People's Fighters Organization.

May 31—*The New York Times* reports that the government has signed a multimillion-dollar contract with the U.S. defense contractor Rockwell International to set up a communications intelligence system.

June 20—Elections are held for the National Assembly, the first under the new one-party system introduced earlier this year.

ISRAEL

(See also *Intl, Middle East Crisis; Romania; U.S., Foreign Policy*)

May 18—Premier Yitzhak Rabin appoints Major General Rehavan Zeevi as special adviser for intelligence matters.

June 1—Premier Yitzhak Rabin appoints Major General Ariel Sharon adviser to the Premier.

June 2—In response to Egypt's reopening of the Suez Canal, Rabin announces the partial withdrawal of Israeli forces along the canal.

June 10—Premier Rabin leaves for talks in Washington, D.C.

June 13—In reaction to the June 12 agreement between Syria and Jordan to coordinate military and political planning, Defense Minister Shimon Peres accuses Syria of trying to create "an aggressive alignment" against Israel.

June 17—The government announces a 2 percent devaluation of the Israeli pound. Frequent small devaluations are expected.

ITALY

May 20—Government employees, airport personnel and workers in service industries begin a week-long strike to protest a variety of economic issues.

June 17—Election returns show the Communist party winning 33.7 percent of the total popular vote in the June 15 local, provincial and regional elections; the Christian Democrats still hold a majority with 35 percent of all votes cast. The Communists win 4.5 percent more votes than they did in 1972; the Christian Democrats lost 2.6 percent of the 1972 vote.

JORDAN

(See also *Intl, Middle East*)

May 5—In Washington, D.C., King Hussein and State Department officials reach an agreement; the U.S. will sell Jordan a HAWK air defense system at an estimated cost of \$100 million.

KENYA

June 3—A parliamentary committee, appointed to investigate the death of a member of Parliament, reports that there has been a "massive and determined cover-up campaign" by police and security officers to hide the facts of the assassination.

June 11—Parliament defeats a government motion to discredit the report of the investigating committee. Parliament votes to "accept" the committee findings and supports the committee recommendations that police and security officers be suspended or dismissed.

Deputy Minister of Works John Keen is dismissed by President Jomo Kenyatta after he raised questions on Kenyatta's policy toward massive "illegal ivory exports."

KOREA, PEOPLE'S DEMOCRATIC REPUBLIC OF (North)

(See also *Cambodia; China; Yugoslavia*)

May 24—*The New York Times* reports a troop build-up along the demilitarized zone between North and South Korea.

KOREA, REPUBLIC OF (South)

(See also *Korea, North*)

May 10—In Seoul, nearly 1.5 million people attend a rally to support President Chung Hee Park's request for increased military preparedness against a possible attack from North Korea.

May 21—President Park meets with his leading political opponent, Kim Young Sam, to discuss methods of insuring internal security against invasion from the north.

LAOS

May 7—In the coalition government, Deputy Premier Phoumi Vongvichit, representing the Pathet Lao, and Leuam Insisiengmay, representing the Vientiane forces, agree to stop the fighting that has disrupted the April cease-fire.

May 9—5 pro-American Cabinet ministers resign.

May 14—U.S. Agency for International Development (AID) missions in Luang Prabang and Savannakhet are attacked by anti-American student demonstrators. In Savannakhet, 3 American AID employees are held hostage and put under house arrest by the demonstrators.

May 16—The demonstrators take over the AID compound; they place 14 American AID employees under voluntary house arrest and send them home.

May 17—The right-wing commander of the air force, General Bouathong Phothivongsa, resigns.

May 19—The government announces a series of regulations restricting travel within the country and abroad.

May 20—Pathet Lao troops are reportedly seizing control of towns previously under rightist control.

May 22—The AID headquarters in Vientiane is looted by students and Laotian employees of AID.

Students in Savannakhet release 14 Americans held under house arrest, who fly to Thailand.

May 23—Premier Souvanna Phouma orders government troops not to resist when Pathet Lao troops come into their territory.

May 28—In an agreement signed by Laotian students and AID officials, the U.S. agrees to withdraw all American and other foreign employees of AID from the country by June 30; the U.S. also agrees to pay Laotian employees of the agency until the agency is closed.

In Savannakhet, students leave the AID headquarters and release the 3 Americans they were holding captive.

May 30—*The New York Times* reports that Pathet Lao-led People's Courts are clearing government offices of undesirable officials by forcing them to resign.

June 2—In Vientiane, U.S. Assistant Secretary of State Philip C. Habib meets with Premier Souvanna Phouma and Foreign Minister Phoumi Vongvichit.

June 4—In Savannakhet, the new mayor, Boun Signavong, orders price controls, the "registration" of rightists and the seizure of all property belonging to rightist leader Prince Boun Oum.

June 13—The Pathet Lao accuses the U.S. Central Intelligence Agency of continued involvement in Laos. Also, it charges that Rosemary Conway, an American arrested June 5, is a CIA agent.

LEBANON

May 15—Premier Rashid al-Solh submits his resignation. In a speech to Parliament, he blames the right-wing Phalangists for the April fighting. He also says that Muslims should be given full citizenship and allowed to hold posts in the armed forces.

May 21—In Beirut, fighting resumes between Palestinian guerrillas and members of the right-wing Phalangist party.

May 23—President Suleiman Franjeh appoints a military Cabinet, the first in the country's history, headed by Nureddin Rifai, a retired brigadier general.

May 27—The military Cabinet resigns after it fails to restore order. Strong political opposition came from the Muslims, who comprise 60 percent of the population.

May 28—President Franjeh asks Rashid Karami—a powerful Muslim political leader and former Prime Minister—to form a new Cabinet. The week-long fighting has brought the total of dead to 80 and the wounded to over 200.

June 1—In fighting between Christians and Muslims, Naim Bordkan, chief of the militiamen of former President Camille Chamoun, is killed.

June 28—For the 5th day, street fighting continues in Beirut.

June 29—Muslim leaders agree not to demand the exclusion of Phalangists from the new Cabinet.

Rioting continues; nearly 800 people have been killed in the fighting between Phalangists and Palestinians in the last 2½ months.

June 30—Premier-designate Rashid Karami names a new Cabinet.

LIBYA

May 23—It is reported that last week Colonel Muammar el-Qaddafi and Soviet Premier Aleksei N. Kosygin signed an agreement in which the U.S.S.R. will sell Libya more than \$1-billion worth of military equipment.

MALAGASY REPUBLIC

May 17—The military government announces amnesty for nearly 200 people arrested on charges of involvement in the assassination of President and Premier Richard Ratsimandrava, February 11.

June 15—Foreign Minister Didier Ratsiraka is named President and head of the Revolutionary Council.

MOZAMBIQUE

June 25—Samora M. Machel is sworn in as President of the newly independent state.

PHILIPPINES, THE

June 7—President Ferdinand E. Marcos arrives in China for a 5-day visit. He is met by Chinese Chairman Mao Tse-tung.

June 9—In Peking, it is announced that President Marcos and China's Premier Chou En-lai have signed an agreement to establish diplomatic relations. All Philippine relations with the government on Taiwan are severed by this new agreement.

PORTUGAL

(See also *Intl, EEC, NATO; Mozambique*)

May 14—The military government nationalizes the cement, cellulose and tobacco industries and imposes wage controls.

May 15—President Francisco da Costa Gomes appoints General Moraes da Silva to replace General Narcisco Mendes Dias as air force chief of staff. Silva is aligned with the left wing of the armed forces movement.

May 20—The government closes the Socialist newspaper *Republica*.

May 22—Mario Soares, leader of the Socialist party, accuses the military government of favoring the Communist party; he threatens to withdraw the Socialist party from the coalition Cabinet if discrimination continues.

May 28—At the end of a 16-hour session, the Armed Forces Assembly establishes a study group to determine whether the 4-party coalition government should be abandoned in favor of an all-military Cabinet.

June 2—President Francisco da Costa Gomes addresses the opening session of the Constitutional Assembly.

June 6—The government nationalizes Lisbon's transportation system and places a freeze on all assets of anyone suspected or found guilty of "harming the economy."

June 10—In anti-government demonstrations in the Azores, 2 Portuguese connected with the American and French consulates are arrested. The civilian governor is forced to resign by the demonstrators.

Portuguese Territories

ANGOLA

May 2—In Luanda, after 4 days of fighting between members of the Popular Movement for the Liberation of Angola and the National Front for the Liberation of Angola, the death toll reaches 250.

May 10—In an attempt to prevent a civil war, the Lisbon government calls for an emergency meeting with the 3 fighting liberation movements.

June 6—In Luanda, the headquarters for the National Union for the Total Independence of Angola is attacked with mortars and grenades.

June 8—Heavy fighting continues in Luanda although a cease-fire was ordered by the military chiefs of the rival groups.

June 16—In Nakuru, Kenya, members of the feuding black Angolan liberation movements meet under the auspices of Kenyan President Jomo Kenyatta.

June 21—In Nairobi, Kenya, the 3 liberation movements issue a joint communiqué announcing that they have reached agreement on the main problems of an independent Angola.

CAPE VERDE ISLANDS

June 30—Elections are held for the 56-member National Assembly.

RHODESIA

June 1—In Salisbury, police kill 11 black Africans and wound 11 others as the police attempt to stop fighting between 2 black African groups, the Zimbabwe African National Union and the Zimbabwe African People's Union.

June 3—The secretary general of the African National Council announces the government's decision not to require a cease-fire between rival black groups before joining in talks preliminary to a constitutional conference. The council agrees not to insist on the release of political prisoners.

June 25—The legislature votes 48 to 14 to extend the 10-year state of emergency one more year.

ROMANIA

June 1—Israeli Foreign Minister Yigal Allon ends a 4-day visit.

June 11—President Nicolae Ceausescu arrives in Washington, D.C., for a visit with U.S. President Gerald Ford.

SAUDI ARABIA

May 18—The Council of Ministers adopts a 5-year economic plan calling for an expenditure of \$140 billion.

SOMALIA

(See *U.S.S.R.; U.S., Foreign Policy*)

SOUTH AFRICA

May 2—The government restores to urban blacks the right to hold 30-year leases on homes in black townships surrounding white cities.

May 19—The Progressive party and the Reform party, both white opposition groups, merge.

May 21—Prime Minister John Vorster agrees to negotiate independence for Namibia but refuses to allow U.N. supervision.

SPAIN

(See also *U.S., Foreign Policy*)

May 14—In Guernica, 4 people are killed in fighting between the police and Basque separatists.

May 23—The government announces that it will no longer delay granting independence to the Spanish Sahara; it is ready to "transfer sovereignty . . . in the shortest period possible."

June 11—In a defiant gesture, tens of thousands of workers in Bilbao go on strike to protest the government's repressive actions in the Basque provinces in the last 6 months.

SUDAN

(See *Ethiopia*)

SYRIA

(See also *Intl, Middle East*)

May 21—The government agrees to a 6-month extension of the U.N. peace-keeping force on the Golan Heights.

TAIWAN

(See *Philippines; U.S., Foreign Policy*)

TANZANIA

May 21—3 U.S. students and a Dutch woman are kidnapped from a wildlife station in the western part of the country by 40 armed Africans.

May 25—One captive, an American woman, is released by her kidnappers, who are holding 3 other hostages.

May 26—The government rejects the demands of the kidnappers, who are identified as members of the Marxist People's Revolutionary party, operating from Zaire.

June 28—Guerrillas free unharmed 2 of the 3 hostages they have held since May 21.

THAILAND

(See also *Cambodia; U.S., Foreign Policy; Vietnam [North]*)

May 5—The U.S. government begins to remove 120 U.S.-built planes flown into the country by fleeing South Vietnamese pilots.

May 14—The government demands that the U.S. remove immediately the 1,100 marines who landed without permission this morning at the U.S. U Taphao air base. The marines were sent to Thailand to assist with the rescue of the U.S. ship, the *Mayaguez*, captured by Cambodian soldiers.

May 15—U.S. marines are flown out of the country. The government accuses the U.S. of a "breach of faith."

May 16—Premier Kukrit Pramoj announces the recall of the Thai ambassador to the U.S.

May 19—The government accepts an apology from the U.S. June 4—In Bangkok, U.S. Assistant Secretary of State Philip Habib meets with Premier Kukrit Pramoj.

June 7—In a joint statement, the U.S. and Thailand make public the timetable for the withdrawal of American troops and planes. All U.S. forces are scheduled to leave by March, 1976.

June 29—Premier Kukrit Pramoj leaves Bangkok for Peking to establish diplomatic relations with China.

TURKEY

(See also *Intl, Cyprus Crisis; U.S., Foreign Policy*)

May 31—Meeting in Brussels, Premier Suleyman Demirel and Greek Premier Constantine Caramanlis agree to guidelines for talks on areas involving the 2 countries.

June 17—The government officially notifies the U.S. government that, unless the U.S. arms embargo is lifted within 30 days as a first step, there will be a "suspension of activities" at some U.S. bases. Turkey is also demanding that talks on the status of U.S. bases there begin within 30 days.

UGANDA

June 1—President Idi Amin signs a decree nationalizing all land.

June 11—Denis Hills, a British author, is sentenced to death by a military tribunal on treason charges, because he described Amin as a "village tyrant" in an unpublished book. Amin issues a 6-point ultimatum to be acknowledged by the British Queen or Prime Minister Harold Wilson by June 20.

June 19—Queen Elizabeth II of England sends a personal message to President Amin asking him to spare the life of Denis Hills.

June 20—President Amin postpones Hills's execution. Amin now insists that only a visit by British Foreign Secretary James Callaghan can save Hills's life.

June 23—In an address to the British House of Commons, Foreign Secretary Callaghan says that he will not go to Uganda.

U.S.S.R.

(See also *Egypt; Libya; U.S., Foreign Policy, Military*)

May 5—Soviet officials conclude 3 weeks of meetings in

Moscow with representatives of the Arab countries on a one-to-one basis.

May 19—Foreign Minister Andrei A. Gromyko meets with U.S. Secretary of State Henry Kissinger in Vienna.

May 22—Aleksandr N. Shelepin, removed from the Politburo last month, resigns as head of the national trade union organization.

June 7—The government successfully completes 6 days of rocket tests in the Pacific.

June 12—The government denies U.S. Secretary of Defense James Schlesinger's June 10 charge that the Soviet Union is constructing a missile storage base in Somalia.

June 13—Soviet party leader Leonid Brezhnev, in his 1st public speech in 5 weeks, calls for worldwide arms reduction and disarmament, emphasizing the "more terrifying" new weapons being developed.

June 18—The government makes public a message it has sent to the Japanese government in which it expressed its hope that Japan would not sign an anti-Soviet clause in her treaty of peace and friendship with Peking.

UNITED KINGDOM

Great Britain

(See also *Intl. Commonwealth of Nations; Uganda*)

May 1—A national sales tax of 25 percent, up from 8 percent, goes into effect.

May 5—The government decides to close private wings in public hospitals.

May 7—Queen Elizabeth II and Prince Philip leave Hong Kong for Japan, the first visit to Japan by a British monarch.

May 16—The Department of Employment reports a 3.9 percent price increase for the month of April—the highest monthly increase recorded since 1947.

May 21—The government agrees to grant independence to the Solomon Islands protectorate by mid-1977, if Parliament approves.

June 5—A national referendum is held to decide whether Britain should remain in the European Economic Community.

June 7—The final results of the referendum show that 67.2 percent of those voting favor British membership in the Common Market. All 4 members of the United Kingdom vote in favor of membership.

June 10—Secretary of State for Industry Anthony Wedgwood Benn is transferred to the post of secretary of energy. His transfer comes in the wake of the June 5 referendum; he campaigned against British membership.

June 16—Foreign Secretary James Callaghan announces the termination of an agreement with South Africa for British use of a naval base at Simonstown, South Africa. The government is protesting South Africa's racial policies.

Northern Ireland

May 1—Elections are held for a 78-member commission to work out a plan for self-government.

May 3—The United Ulster Unionist Council, a 3-party coalition that opposes power-sharing with Catholics, wins 46 of the 78 seats on the commission.

UNITED STATES

Administration

May 5—In a statement to reporters, Secretary of State Henry Kissinger declares that neither he nor the National Security Council were ever involved in domestic operations of the Central Intelligence Agency.

May 7—Federal Energy Administrator Frank G. Zarb an-

nounces that 9 Midwestern utility companies have been notified that the administration plans to order them to shift from oil to coal or natural gas as a boiler fuel.

May 14—President Gerald Ford rejects a plea from New York City Mayor Abraham Beame for financial help; the city needs \$1.5 billion to meet its June expenses.

At the President's order, construction of a swimming pool at the White House begins.

May 19—The President establishes a 17-member committee to oversee the resettlement of 135,000 refugees from Cambodia and Vietnam.

May 27—The President says that he is imposing a 2d fee of \$1 a barrel on imported oil starting June 1; he also intends to phase out price controls on domestic oil in June.

The Food and Drug Administration proposes to treat superpotent vitamins and minerals as food when they are generally regarded as safe and are sold to supplement diet.

June 2—The Federal Trade Commission announces plans to invalidate private agreements and state laws that prevent druggists from advertising the price of prescription drugs.

The Department of Health, Education and Welfare reveals that Hawaii, Indiana, Minnesota, Montana, New Mexico, North Dakota and Pennsylvania have been penalized a total of \$1.7 million for failing to inform, test or treat eligible poor children under a federal program established in 1967. Policies in six additional states are being reviewed.

June 8—Attorney General Edward H. Levi cautions that no President has constitutional power to order the assassination of a foreign head of state.

June 10—President Gerald Ford says that world oil prices should not rise more than 7 or 8 percent and possibly should be cut.

June 20—Dixy Lee Ray, the State Department's top science adviser, resigns from the State Department. She charges that her office has not been consulted on important policy.

June 26—President Ford names F. David Mathews, president of the University of Alabama, as secretary of the Department of Health, Education and Welfare.

June 28—The Commission on the Organization of the Government for the Conduct of Foreign Policy recommends that the post of Secretary of State and Assistant to the President for National Security be divided after Henry Kissinger, the present incumbent, leaves office. The 10-member commission was established 2 years ago by Congress and President Richard Nixon to study U.S. foreign policy-making.

June 30—A new federal energy development plan is made public by the Energy Research Development Administration. The plan emphasizes coal and control of the atom as the primary energy priorities.

Economy

(See also *Intl. International Energy Agency; U.S., Administration*)

May 2—The Labor Department reports that in April the national unemployment rate rose 0.2 percent to 8.9 percent; 8,167,000 people were unemployed in April.

May 15—The Federal Reserve Board announces that it is reducing its discount rate to 6 percent from 6.25 percent.

May 20—The Commerce Department reports that, in the first quarter of 1975, corporate profits registered a record decline.

- May 21—The Labor Department reports that the consumer price index rose by 0.6 percent in April.
- May 29—The administration's new composite index of leading economic indicators reveals an increase of 4.2 percent in April. The index rose 1 percent in March. The old index showed a rise of 4.2 percent in April.
- May 30—The administration releases revised budget projections for fiscal 1976; the deficit is estimated at \$59.9 billion. Unemployment is estimated at an average of 7.9 percent.
- June 2—The Commerce Department reports that manufacturers' inventories were reduced \$1.5 billion, 0.8 percent, in April, the largest percentage decline for 1 month since May, 1958.
- June 5—The Labor Department reports that the wholesale price index for May rose 0.4 percent after seasonal adjustment. The key index of industrial commodity prices rose 0.2 percent.
- June 6—The Labor Department reports that the nation's unemployment rate rose to 9.2 percent of the labor force in May, a post-World War II record of 8,538,000 unemployed. In the same month, 316,000 people joined the labor force.
- June 8—The National Urban League reveals that the unemployment rate for black people reached 25.7 percent in the first quarter of 1975.
- June 16—The Federal Reserve Board reveals that industrial production declined 0.3 percent in May.
- June 17—The Department of Commerce reports that housing starts in May were at an annual rate of 1,126,000 units, a rise from 986,000 starts in April.
- June 20—The Labor Department reports that the consumer price index rose 0.4 percent in May.
- June 26—The Commerce Department reports that its composite index of leading economic indicators rose 2.1 percent in May, a rise for the 3d straight month. The nation's trade surplus in May was \$1.05 billion.

Foreign Policy

(See also *Cambodia; Iran; Israel; Jordan; U.S.S.R.; Zaire*)

- May 1—James R. Schlesinger, secretary of defense, tells a news conference that the evacuation of refugees from South Vietnam has ended.
- May 2—The President says that the total number of Vietnamese seeking asylum in the U.S. is 123,000, including those already in the U.S. who want to remain.
- May 6—In a televised news conference, the President says the U.S. will stand by its allies.
- In the same news conference, the President asks Americans to welcome the Vietnamese refugees.
- May 7—The President formally announces the end of the "Vietnam era."
- May 12—A U.S. merchant ship, the *Mayagüez*, is boarded and seized by Cambodian military in the Gulf of Siam. The 39-member crew is taken captive.
- May 14—U.S. war planes attack and sink 3 Cambodian gunboats. After diplomatic measures fail, 200 U.S. marines land on Koh Tang Island and effect the release of the captive crew.
- May 16—The U.S. Defense Department reveals that navy planes attacked the airfield at Ream, on the Cambodian mainland, and destroyed an oil depot at the port of Sihaoukville after the *Mayagüez* crewmen were released.
- Secretary of State Kissinger says that the U.S. rescue of the *Mayagüez* shows the world that the U.S. cannot be pushed beyond certain limits.
- May 19—Kissinger begins talks on disarmament with Soviet

Foreign Minister Andrei A. Gromyko in Vienna.

- May 20—In a casualty report, the Defense Department says that in the rescue of the *Mayagüez* 15 Americans have been killed, 3 are missing and 50 are wounded.
- May 23—In Hong Kong, newsmen inspect the cargo of the *Mayagüez* and find it to be nonmilitary.
- May 27—The State Department makes a statement regretting the Israeli armed incursions into Lebanon.
- May 28—Arriving in Brussels, President Ford tells members of the North Atlantic Treaty Organization that the U.S. commitment "to this alliance will not falter."
- May 31—The President flies from Brussels to Madrid to discuss the U.S. air and naval presence in Spain; he meets with Generalissimo Francisco Franco.
- June 2—In Salzburg, President Gerald Ford and Egyptian President Anwar Sadat report that their 2-day conference on a Middle East settlement was "an important step toward peace."
- June 3—Ending his European trip, the President calls on Pope Paul VI and Italian President Giovanni Leone.
- June 4—A Defense Department official discloses that the U.S. is negotiating for a purchase of \$30-million worth of Belgian machine guns in order to persuade Belgium to buy American rather than French jet fighter planes.
- State Department spokesman Robert Anderson says the U.S. has refused a North Vietnamese offer to "normalize" relations.
- June 7—A State Department official reveals that the U.S. has withdrawn all its combat aircraft from Taiwan. The U.S. military force there is to be cut 30 percent to 2,800 men by the end of June.
- June 9—Testifying before the House Armed Services Subcommittee, a Defense Department official reveals U.S. plans to sell 3 diesel-powered submarines to Iran.
- June 10—Secretary of Defense James R. Schlesinger charges that the Soviet Union is storing antiship missiles at a Somali port on the Gulf of Aden.
- June 12—President Ford and Israeli Premier Yitzhak Rabin end two days of talks; they agree about the advantages of a limited agreement in the Sinai.
- June 13—The State Department reveals that the U.S. plans to admit political refugees from Chile.
- June 17—In Washington for a state visit, West German President Walter Scheel speaks to a joint session of Congress.
- June 23—In Washington, American sources say the U.S. and the U.S.S.R. have agreed in principle on a treaty to outlaw environmental warfare.

Labor and Industry

- May 2—The Securities and Exchange Commission reveals that the Gulf Oil Corporation dispersed some \$4.2 million to bribe foreign politicians to favor the company's assets overseas.
- May 19—The Justice Department's suit against the International Business Machines Corporation on charges of illegal monopolistic practices opens in federal district court. The Justice Department asks that IBM be broken up into several separate entities.

Legislation

- May 1—Because of its potential inflationary effect, the President vetoes the bill that would increase price supports on farm products.
- May 7—The House votes 293 to 115 to pass a bill requiring strip mining coal operators to restore strip-mined land to productive use after mining operations end. The

Senate passed the bill by voice vote last week; it goes to the White House.

May 13—In a 245 to 182 vote, the House fails to override the President's veto of the emergency farm bill. This is the first time the 94th Congress has tried to override the President's veto.

May 14—The House and Senate approve a concurrent resolution setting a target ceiling of \$367 billion on federal spending in fiscal 1976, with a consequent deficit of \$68.8 billion.

May 16—The Senate votes 79 to 2 to approve a \$405-million spending program for refugee resettlement; the House approved the bill May 14.

May 20—The House votes 311 to 95 against reducing U.S. military troop strength overseas.

The President vetoes the strip mining control bill.

May 24—The President signs 2 bills that provide \$405 million for the resettlement of Vietnamese and Cambodian refugees.

May 29—The President vetoes the \$5.3-billion bill that would have provided funds for jobs for the unemployed.

June 3—Regulations released by the Department of Health, Education and Welfare banning discrimination on the basis of sex in the nation's schools and colleges are sent to Congress by President Ford. The regulations are to be accepted or rejected by Congress within 45 days, in accordance with a provision for congressional review in Title IX of the Educational Amendments of 1972, under which the new regulations were issued.

June 4—Voting 277 to 145, the House fails to muster enough votes (a two-thirds majority) needed to override the President's veto of the \$5.3-billion emergency employment bill. Last month the House failed to override the President's veto of a farm price support bill.

June 5—President Ford reluctantly signs a bill facilitating state use of \$11.1 billion in impounded highway construction funds, by temporarily relaxing the requirements that states put up matching funds.

The President signs legislation reorganizing federal regulations of the securities industry.

June 10—Voting 278 to 143, the House fails to override the President's veto of a strip mining control bill.

June 11—The Senate completes congressional action on a \$1.2-billion emergency housing bill and sends it to the White House.

The Senate votes 60 to 36 to confirm Stanley K. Hathaway as secretary of the interior.

June 12—The Senate completes congressional action on a \$373-million summer job bill and sends it to the White House. It is hoped that the legislation will provide summer jobs for 840,000 poor youths.

June 13—The President signs a \$15-billion supplemental appropriation bill to fund payments to veterans and Social Security pensioners, among other programs.

June 24—President Ford vetoes the \$1.2-billion emergency housing bill. He orders the release of \$2 billion in previously authorized funds for government purchase of home mortgages, and asks Congress to authorize \$7.7 billion in addition for the mortgage assistance program.

June 25—For the 4th time, the House fails to override the President's veto; it votes 268 to 157 (16 short of the necessary two-thirds vote) to override the veto of the \$1.2-billion housing bill.

June 26—Voting 83 to 3, the Senate completes congressional action on an extension of the 65-week emergency unemployment compensation bill; the House passed the measure by voice vote earlier today.

June 27—The Senate passes by voice vote a modified

version of the previously vetoed housing bill and sends it to the White House.

Military

June 20—Secretary of Defense James Schlesinger declares that the U.S.S.R. has deployed 60 intercontinental ballistic missiles with multiple independently targetable warheads in the last half year.

Political Scandal

May 14—A federal district court judge fines former Secretary of Commerce Maurice Stans \$5,000 for violating federal campaign laws in campaigning for the reelection of President Richard M. Nixon. Stans pleaded guilty to the charges.

June 2—Vice President Nelson Rockefeller tells news reporters that his commission (investigating the Central Intelligence Agency) has found no massive pattern of illegality.

June 6—The President receives a report on the CIA from Vice President Rockefeller.

June 9—The President says he is giving the 299-page Rockefeller Commission report on the CIA to the Justice Department and 2 congressional committees; the report is to be released tomorrow, but information on alleged CIA plots to assassinate foreign officials will not be made public because it is "incomplete and extremely sensitive."

June 10—The Rockefeller Commission report, released today, says that "the great majority" of CIA activities were legal, but it reports on the illegal activities of a CIA domestic spying operation against Americans called "Operation CHAOS."

The Rockefeller Commission reveals that for more than 20 years the Department of Justice had a secret agreement to give the CIA authority to decide whether agency personnel should be prosecuted; the commission charges that this was an abdication of "statutory" duty on the part of the Justice Department.

June 13—Senator Frank Church (D., Idaho), chairman of the Senate Select Committee on Intelligence, says his committee has seen no evidence linking U.S. Presidents to any assassination plots against foreign leaders.

June 15—Vice President Nelson Rockefeller says that his commission found there is no "conclusive information" of any involvement of President John Kennedy or Attorney General Robert Kennedy in any alleged assassination plots formulated by the CIA.

June 27—Former President Richard Nixon's lawyers announce that he testified voluntarily before a grand jury, under questioning by lawyers from the special Watergate prosecution force in California June 23 and 24.

Politics

May 29—Former Governor of North Carolina Terry Sanford announces his candidacy for the Democratic presidential nomination in 1976.

June 16—The President endorses Vice President Nelson Rockefeller as a running mate in the 1976 election.

June 18—The President names Army Secretary Howard H. Callaway as chairman of his 1976 campaign, in the first formal step he has taken to announce his candidacy for the Republican nomination in 1976. Callaway resigns as Army Secretary.

Supreme Court

May 12—The Supreme Court refuses to review a federal district court decision that ruled the Boston public school system was unconstitutionally segregated; it thus lets

stand the order to Boston officials to work out a plan for desegregation.

May 19—In 2 separate 6-3 votes, the Supreme Court rules that a Pennsylvania law providing state aid for private and parochial schools for auxiliary services is unconstitutional; the state can lend secular textbooks to church-affiliated schools.

The Court rules that financial responsibility for a collision at sea should be divided according to the relative responsibility of the ships involved, overriding an 1854 ruling that damages must be divided equally.

May 27—The Supreme Court lets stand a ruling permitting the Central Intelligence Agency to refuse to permit a former agent to publish in a book material it regards as "classified."

June 2—The Supreme Court rules 5 to 2 that a construction union is not exempt from federal antitrust laws when it forces a contractor to boycott nonunion subcontractors.

June 16—The Court rules unanimously that a uniform minimum legal fee charged by lawyers for real estate transfers is a form of illegal price fixing in violation of federal anti-trust legislation.

June 23—The Supreme Court announces that the capital punishment case has been placed on the calendar for a second hearing next fall; 287 convicted criminals are under death sentence awaiting the decision.

The Court rules 6 to 3 that a city ordinance making drive-in movie theaters criminally liable if they show films including nudity that are visible from outside the theater grounds is an unconstitutional interference with free speech.

June 24—The Court rules 5 to 3 that a city can alter its racial composition by annexing a white suburb if the move serves a legitimate government aim. The case involves Richmond, Virginia.

June 25—The Court rules 5 to 4 that city residents cannot challenge suburban zoning rules on the grounds that zoning rules deliberately price out the poor and racial minorities. The case involves Penfield, New York.

June 26—The Court rules unanimously that a mental patient cannot be kept in a mental institution against his will without treatment if he is not dangerous and is able to survive outside the institution.

June 30—The Court rules 6 to 3 that a competent person accused of a crime has the right to refuse professional legal counsel and to conduct his own defense.

Trust Territories

June 17—In a plebiscite, 78.5 percent of the voting population of the northern Mariana Islands vote to become American citizens and to establish the islands as a U.S. commonwealth.

VIETNAM, DEMOCRATIC REPUBLIC OF (North)

(See also *U.S., Foreign Policy*)

May 21—A 13-member government delegation arrives in Bangkok for talks with Thai officials in an attempt to normalize relations between the 2 countries.

June 3—In a speech to the National Assembly, Premier Pham Van Dong offers to normalize relations with the U.S. if the U.S. "seriously implements" its 1973 promise to aid North Vietnam.

June 8—A statement is issued after the 1st meeting of the 5th session of the National Assembly on June 6; it urges that Hanoi be made the capital of a unified Vietnam.

June 11—The government refuses to allow a search for

Americans missing in action until the U.S. agrees to provide postwar economic assistance.

VIETNAM, REPUBLIC OF (South)

(See also *Vietnam, North*)

May 1—*The New York Times* reports that the Communist rulers have declared a takeover of all areas of resistance.

The government indicates that "Saigon" will continue to be the official name of the capital city and that Ho Chi Minh City will be its popular name.

May 5—The military committee governing Saigon extends the deadline for all former officials to turn themselves in until the end of the month.

May 7—A Saigon radio report says that Saigon has returned to normal.

The 11-member ruling military committee makes its first public appearance in Saigon; General Tran Van Tra is acting as head.

May 9—The ruling military committee outlaws all foreign currency. The old South Vietnamese currency is declared the only legal tender; checks are banned.

May 15—A 3-day celebration begins with a government offer to establish diplomatic relations with all countries, including the U.S.

May 19—U.S. intelligence reports indicate that North Vietnam's 4th ranking Politburo member, Pham Hung, is the apparent political leader in Saigon.

May 22—The government outlaws the sale or possession of all printed material published under the old government.

May 23—In Washington, D.C., the South Vietnamese embassy is closed.

May 28—Saigon radio indicates that the basic unit of South Vietnamese society will be about 12 family groups.

June 6—*Giai Phong*, the official Saigon newspaper, reports the 1st meeting of the Cabinet of the Provisional Revolutionary government on June 4.

June 19—The government orders the permanent closing of all banks in South Vietnam except the National Bank of Vietnam.

YUGOSLAVIA

June 9—North Korean President Kim Il Sung leaves Belgrade after an official visit with President Tito.

ZAIRE

June 17—President Mobutu Sese Seko claims that an unsuccessful attempt has been made on his life. An editorial in the government-controlled daily newspaper *Elima* implies that the would-be assassins came from the U.S.

June 18—6 army officers are arrested on charges of attempting to overthrow the government. The government newspaper accuses the U.S. of conspiring to support the plotters.

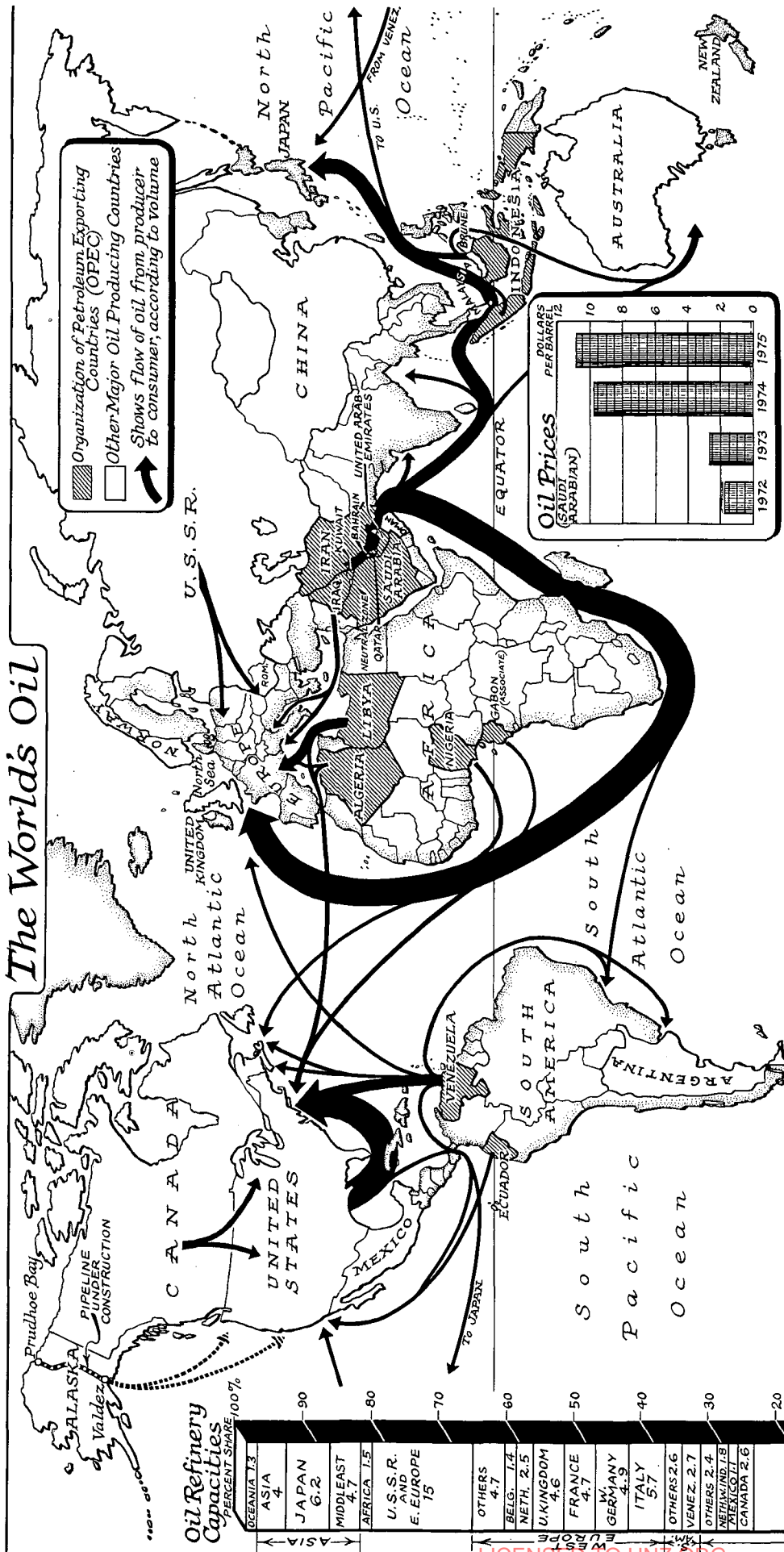
June 20—The U.S. ambassador is asked to leave. The government withdraws Zaire's ambassador to the U.S.

ZAMBIA

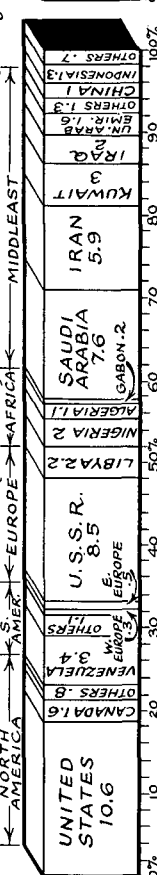
May 27—President Kenneth Kaunda announces the resignation of Prime Minister Mainza M. Chona. Elijah H. K. Mudenda is appointed to replace him.

June 30—President Kaunda nationalizes privately held land, movie theaters, private hospitals and the British-owned newspaper, *The Times of Zambia*.

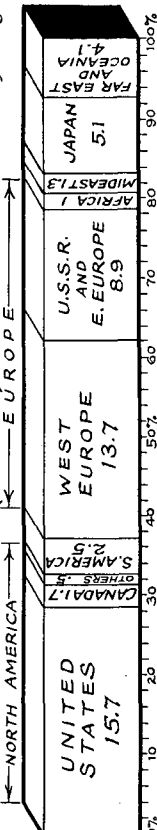
The World's Oil



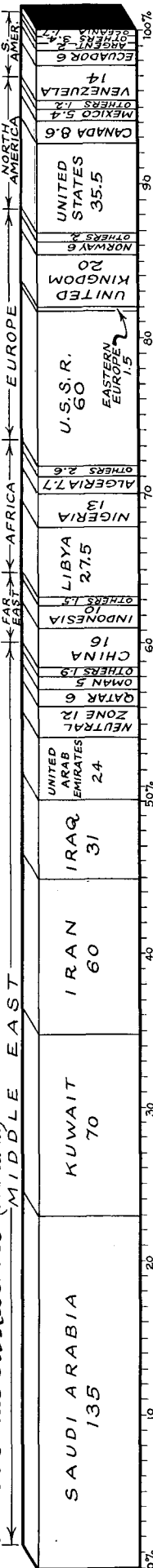
Production of Crude Oil (in millions) Total 56.7 million barrels per day



Demand for Crude Oil (in millions) Total 54.5 million barrels per day



Proven Crude Oil Reserves (in billions)



Total 590.5 billion barrels

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